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A fistful of dollars: Transmission of global funding shocks to EMs

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Abstract

In this paper, we study transmission of global funding shocks to emerging economies (EMs) from the perspective of interbank markets. Money markets enable banks to engage in risk-sharing against liquidity shocks and are sensitive to global funding conditions. Accordingly, we first show that interbank rates better reflect the magnitude of transmission of foreign liquidity shocks to EMs as compared to benchmark short-term bond yields. Next, we disentangle the transmission into its various channels, focusing in particular on two pull factors associated with the domestic banking microstructure: dependence on wholesale funding and share of foreign banks. Our results indicate that money market rates in EMs react to global shocks, and that in particular dependence on wholesale funding has a significant role to play. Finally, we provide evidence that tools of macro-prudential policy like reserve requirements can help alleviate liquidity shocks to the EM banking system, weakening this global transmission.

JEL Classification: E43, E44, E52, E58, F42, G14, G15, G21
Keywords: International transmission of liquidity shocks; quantitative easing; wholesale funding; interbank rates; macro-prudential policy; reserve requirements.

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1 Introduction

As emerging markets (EMs) have grown larger over the last 30 years, they have become more exposed to the global financial cycle in spite of their best efforts to calibrate the pace of their integration. During the global financial crisis (GFC), for instance, the transmission of global liquidity shocks to EM money markets was fast and persistent (Fratzscher and Chudik, 2012; Fratzscher *et al.*, 2016, 2018; Le and Dickinson, 2016).[1] This was somewhat unexpected given the extensive use of capital controls by most of these countries (figure 1).

Consequently, after 2008, there has been a substantial increase in research in international economics on identifying and quantifying spillovers from global liquidity cycles, driven primarily by core economies, to EMs. Positive liquidity shocks, such as US quantitative easing (QE) policies, for example, have led to exchange rate appreciations, reductions in long-term bond yields, stock market booms, and increases in gross capital flows to emerging economies (Bhattarai *et al.*, 2018). On the downside, there is evidence that negative liquidity shocks constitute a tightening of financial conditions, leading to reduced lending and lower real investment in EMs (Bruno and Shin, 2015b; Avdjiev *et al.*, 2018).

In this paper, we focus on money markets, which are defined as markets for short-term funds, with maturities ranging from overnight to one-year. They enable banks to engage in risk-sharing through liquidity provision. The central bank intervenes in this market to control overall liquidity in the system and keep it aligned with the overall stance of monetary policy. The interest rate in the overnight segment, in particular, is often used as an operational target for monetary policy, and rapidly reflects pressures on the financial system (Green *et al.*, 2016). Money markets have been shown to play an important role in transmission of funding conditions, not just domestically, but also globally, which was made apparent during the GFC (Allen and Gale, 2000; Rigg and Schou-Zibell, 2009; Allen *et al.*, 2012; Benoit *et al.*, 2017).[2]

We argue that because money market rates are sensitive to global funding shocks, they are useful in measuring transmission to EMs accurately. We show this by using event study analysis for a sample of 23 EMs. First, we collate a list of important liquidity shocks in two major reserve and invoicing currencies (US dollar and Euro) since 2007. Next, we ascertain the responses of money market rates in a short window around these events. We find that money market rates in EMs fall by roughly 1% in response to a positive liquidity shock, and rise by 3% within five days after a negative liquidity shock. These effects are even stronger if we consider unanticipated events of the post-crisis period. For example, the first QE announcement by the Federal Reserve in 2008 led to a cumulative reduction of interbank rates in EMs by 8%.

To provide a benchmark against which to compare the responses of money market rates,

[1] As an example, Patnaik and Shah (2009–10) find that after the Lehman bankruptcy, Indian money markets came under significant stress, rendering the operating procedure of monetary policy broken. It was surprising given India's relatively closed economy and complex system of capital controls. The overnight call rate, which was 6% on 12 September, shot to 13% by 17 September, and remained elevated (at about 16%) until October. The acute shortage of dollars caused liquidity concerns in other EMs too, such as Brazil, Singapore, Poland, China, and Korea (Rigg and Schou-Zibell, 2009; Moreno and Villar, 2011).

[2] Interbank lending, specially cross-border, is the most volatile component of banking flows and the first to collapse during crises (Kerl and Niepmann, 2014).

we also look at bond yields as a measure of interest rate conditions.[3] We find no effects of positive or negative events on short-term bond yields. Therefore, using bond yields to measure spillovers from advanced economies may lead to severe underestimation of transmission effects. Our finding corroborates the claim that interbank markets and banks, rather than bond markets, are the vectors that transmit global financial conditions to EMs, especially in the "first phase of global liquidity" between 2003 to 2008 (Shin, 2013).

Next, we set up a micro-aggregated macro panel to show that even after collapsing data down to quarterly frequency and controlling for country fundamentals and unobservables, international funding shocks transmit to EM interbank rates. Traditional "push" and "pull" factors are important. We focus in particular on reliance on wholesale funding and foreign banks in their role as important determinants of bank-level liquidity risk – defined as the bank's ability to pay out its short-term liabilities. A bank with a concentration of short-term payables and illiquid assets will be exposed to such risks.

Specifically, we find that a one standard deviation increase in a country's reliance on wholesale funding and share of foreign banks is associated with 10 to 30 basis points increase in money market rates on average, respectively. This result is driven primarily by non-Asian countries in the sample. Rising global risk aversion, using standard proxies as the VIX, can further reinforce the positive link between interbank rates and wholesale funding in particular.

In addition, local banking system liquidity conditions can be significant amplifiers of global shocks as well (Raddatz, 2010). We find that wholesale funding reliance, in addition to global risk aversion, also contributes positively in transmission of global funding shocks to domestic interbank rates, especially after the crisis. This is an interesting result as it indicates countercyclical provision of systemic liquidity to domestic banks may compensate for tightening of global funding conditions (and vice versa), potentially slowing down transmission without affecting monetary policy objectives. Therefore, bank level risk can be moderated by system-wide liquidity conditions.

Liquidity risk in the context of global transmission of financial conditions has different bank-level and system-wide implications (Buch and Goldberg, 2015; Benoit *et al.*, 2017). When times are good, banks with exposure to liquidity risk will be able to meet their funding requirements through market funding. When market liquidity conditions tighten, it will affect banks with weak liquidity positions by more and may have further feedback effects into the market cost of funds. This is also influenced by the fact that bank funding (via deposits), market funding, and central bank liquidity facilities are imperfect substitutes, and the latter two have a larger premium during times of market stress (Angelini *et al.*, 2011; Heider *et al.*, 2015).

In its role as the provider of system-wide liquidity, we investigate policy actions available to the domestic central bank. The use of reserve requirements (RR) as a secondary instrument of monetary policy and liquidity management in EMs is quite popular.[4] RR are

[3]Government bond markets in emerging economies can have significant quantitative and qualitative restrictions on market participation. For example in India, there are numerous caps on foreign investment in rupee denominated bonds, including limits by investor class, maturity and issuer (Patnaik *et al.*, 2013a). Domestically, there are additional restrictions on participation and banks are required to hold a significant portion of their balance sheet in government bonds.

[4]For example, Brazil, India and Turkey reduced required reserve ratios in the aftermath of the GFC

also recognised as lender-focused macro-prudential instruments with some mixed success in dealing with capital flows and credit growth induced by global liquidity shocks (Federico *et al.*, 2014; Raddatz *et al.*, 2015; Cerutti *et al.*, 2017; Agénor *et al.*, 2018). Based on these priors, we investigate the effect of RR as a macro-prudential tool in the transmission of global shocks to interbank rates. We find that they are somewhat successful in impeding transmission.

Money market rates are our preferred barometer for understanding transmission because of their linkages not just with the domestic and international banking sector, but also with other relevant stakeholders. Figure 2 demonstrates these connections and the key conceptual framework. Consider a representative emerging economy, with a current account deficit, a semi-closed capital account, and trend depreciation of the exchange rate. A fraction of firms and banks have unhedged exchange rate exposure because of borrowings from foreign capital markets. There is a central bank, which depending on its policy stance, intervenes actively to manage the exchange rate, or raises interest rates, or both.[5]

Suppose there is a negative funding shock in the US (shown in figure 3). The transmission of this shock to the EM's domestic interbank market could be through various channels. The first is through direct links between domestic and foreign banking sectors. Domestic affiliates of global banks could be required to sell their assets and provide liquidity support to their parents (McCauley and Zukunft, 2008). Domestic EM banks who operate internationally and obtain funding primarily through their affiliates, would be affected as well. Overall, this would add up to a decline in cross-border sources of funding.

In addition, a depreciation of the domestic currency would increase the value of short-term liabilities for banks facing a currency mismatch on their balance sheets. This could amplify the transmission of liquidity shocks. Even if the banks are hedged in their currency exposure (Bruno and Shin, 2015b), the interbank market could still be affected due to the linkages between domestic firms and banks. Specifically, local firms facing a similar currency mismatch on their balance sheets, could make large-scale withdrawals from the banking system to repay their foreign liabilities, thereby leading to capital outflows. In the absence of any action by the central bank, all of these factors would build on each other to draw down liquidity from the interbank markets, thereby increasing money market rates.

However, the central bank can step in and act as a net provider of system-wide liquidity, thereby dampening rates. This can be achieved through fully sterilised intervention, cutting the interest rate, or easing reserve requirements, which would all help ease local liquidity conditions.

The main contribution of our paper is to bring together different strands of the literature and propose money market rates as a summary indicator that accurately measures the extent of transmission of funding shocks to emerging economies. To the best of our knowledge, this has not been explicitly studied before. Further, we show that transmission is crucially linked to local banking sector characteristics – something that policy-makers

and subsequently increased them to manage excess liquidity due to capital flows in 2010-11. Federico *et al.* (2014) have documented that around two-thirds of the EMs in their sample use RR as a macro-prudential instrument.

[5]The central bank's policies may act to aggravate the unhedged exposure of domestic firms (Patnaik and Shah, 2010).

should consider when thinking of policy responses. Finally, we link this to one specific policy action that is popular in EMs – reserve requirements.

The rest of the paper is organised as follows. We first provide a comprehensive overview of the existing literature in section 2. In section 3, we present data sources and descriptive statistics for our variables of interest. Section 4 explores the event study results, while section 5 details the panel results, and section 6 concludes, providing some avenues for future research.

2 Interbank markets and banking microstructure

In this section, we focus on the link between interbank markets and banking sector microstructure. Overall evidence suggests that multinational and internationalised domestic banks will be key in the transmission mechanism. The transmission may also depend on the liquidity management of the banks, for e.g reliance on less stable funding sources, such as the wholesale market. We also briefly explain the intuition behind our control variables, which are guided by the literature on "pull" and "push" factors of global capital flows, leaving the in depth discussion on these variables to section 5.

The banking sectors of emerging economies are made up of three types of banks: domestic, international (conducting cross-border business from their headquarters), and multinational/foreign (conducting cross-border business primarily through their branches or subsidiaries) (McCauley *et al.*, 2010). This decomposition is important because shocks from different sources can propagate to EMs differently depending on the type of bank. Domestic banks in EMs are at most "international" in that they typically do not have many branches or subsidiaries in other countries.[6] These type of banks borrow directly in international markets where they may borrow from own affiliates and other banks in the interbank market or from non-banks like non-financial corporates. Meanwhile, multinational/foreign banks have an additional source of funding – from their parents – who can access international markets on their behalf and then allocate funds according to a locational "pecking order" (Cetorelli and Goldberg, 2012b; Gambacorta *et al.*, 2019).

Turning first to internationalised domestic EM banks, Bruno and Shin (2015a) and Bruno and Shin (2015b) show the role played by these types of banks in transmitting a US monetary policy loosening to the local economy. When the foreign interest rate is cut, capital flows to the EM as the local currency appreciates, and the bank builds up leverage by borrowing in US dollars, usually from its own or other EM bank foreign affiliates (Cerutti *et al.*, 2018). In this way, there is a loosening of monetary conditions in the local economy even though no action has been taken by the domestic central bank.

Presence of *multinational* banks conditional on banking sector competition has been seen to improve interest rate pass through and domestic monetary transmission in developing countries and EMs (Gopalan and Rajan, 2017). As far as global transmission is concerned, the literature suggests that *multinational* banks operating out of EMs have different transmission roles depending on whether the shock is to the host or home country. For example, Dinger (2009) studies banks in 10 CEE emerging economies between 1994-2004

[6]The Chinese banking system is an exception to this rule. As of December 2015, they were the tenth largest creditor in the global banking system Cerutti *et al.* (2018).

and shows that foreign banks play a "smoothing" role by increasing their interbank lending to domestic banks when there is negative liquidity shock in the host country. Foreign banks that rely on financially strong parents are able to expand credit supply faster, and do not need to rein it in during times of crises in the domestic country (de Haas and van Lelyveld, 2010).

When the shock is to the home country, however, there are two types of reactions to the shocks, both of which may have negative effects on EMs.[7] The first response is demonstrated by Cetorelli and Goldberg (2012a), who use the example of the US around the crisis to show that when a parent bank faces a shock, affiliates transfer funds to them via internal capital markets and in the process reduce their domestic lending in the host country (see also, for example, McCauley and Zukunft, 2008). The second response to a shock is when the parent bank reallocates its own liquidity based on a locational pecking order (Cetorelli and Goldberg, 2012b), which affects both intrabank and interbank liquidity. Reinhardt and Riddiough (2015) argue that interbank funding is first to be withdrawn when global risk is high. de Haas and van Lelyveld (2011) study 150 largest banks in the world and show that multinational bank subsidiaries had to curtail lending more aggressively than domestic banks after the GFC, and this was specially true for subsidiaries of groups that relied more heavily on wholesale market funding. Kamil and Rai (2010) find precisely this for Latin America. Any adverse movements in international money market conditions or of parent banks' own financial soundness have a significant negative effect on foreign banks' lending in the host countries. However, the propagation of these global shocks is muted where foreign banks' rely more heavily on the domestic deposit base (as opposed to wholesale markets) to fund their local activities.

After the crisis, the role of short-term (unsecured) wholesale funding has become the subject of renewed interest. Wholesale funds include sources of funds other than non-demand deposits, such as commercial papers, repo markets, and interbank loans. Banking systems that rely more heavily on wholesale funding may, during normal times, benefit from diversification in their funding sources (since deposits are considered flighty and fragile in case of bank runs) (Feldman and Schmidt, 2001), but are also significantly more susceptible to liquidity collapses during crises (Rajan, 2006). Since wholesale funding relies on market information regarding banks, it can be both volatile as well as fragile. Huang and Ratnovski (2011) show that the presence of free but noisy public signals on bank quality (such as credit ratings) lowers the incentives of wholesale finance providers to monitor the bank closely, and therefore makes them more likely to liquidate their positions based on extreme signals. Interbank lending, especially cross-border, is the most volatile component of banking flows and the first to collapse during crises (Kerl and Niepmann, 2014). For example, van Rixtel and Gasperini (2013) document the reduction in activity in short-term unsecured interbank markets during episodes of severe financial stress during the Eurozone crisis.

Over-reliance on wholesale funding can increase bank riskiness as well as lower the rate of return on assets (Demirgüc-Kunt and Huizinga, 2010). Raddatz (2010) investigates

[7] Actually, certain peculiar features of EM banking systems may amplify spillovers from global funding shocks in EM interbank markets irrespective of a large presence of global banks, unlike other transmission settings. Specifically, as documented by Cerutti *et al.* (2018), EM banking systems tend to access a majority of their offshore funding through own foreign affiliates based in advanced economies or offshore financial centres. This is very different to advanced economy (AE) banks who tend to access foreign funding through their headquarters.

whether stock market declines in 662 banks immediately after the Lehman bankruptcy could be explained by ex-ante reliance on wholesale funding. The author, using difference-in-differences and event studies, finds that stock prices of banks with high reliance on wholesale funding decreased much more than their within-country peers with lower reliance, showing that the use of this source of funds can play a major role in propagating shocks across borders. When this is combined with the cross-border activities of multinational banks, reliance on wholesale funding further compounds the negative effect on foreign bank lending in the host country when there is a shock to the home country.

Therefore, in our paper, we will try to focus on the transmission mechanism through the funding structure of a bank (reliance on wholesale vs retail funding) more generally, and through foreign banks more specifically.

Our paper also relates to the set of literature that looks at the role of "pull", or global-specific, and "push", or country-specific factors in explaining the response of EM asset prices to global monetary policy announcements and other events. There is mixed evidence about the factors and significant heterogeneity (Fratzscher *et al.*, 2016, 2018; Mishra *et al.*, 2014; Eichengreen and Gupta, 2015; Ahmed *et al.*, 2017). Koepke (2019) in a comprehensive literature survey (table 4) finds that cyclical push factors matter more for portfolio and equity flows whereas banking flows are driven by global risk aversion, global funding conditions, as well as recipient country characteristics. This result is reinforced by Cerutti *et al.* (2019) who find little robust evidence that institutional and macroeconomic fundamentals dampen EM sensitivity to global conditions especially for portfolio flows. We use these insights to adequately control for these factors in our regression analysis.

3 Data description

Our sample consists of the 23 emerging economies included in the MSCI EM index.[8] For the event studies, we use information for the full sample; however, in the panel analysis the number of countries is reduced to 16 due to lack of data on reserve requirements.[9]

Most of the data required for our analysis is taken from Thomson Reuters *Datastream*, IMF *International Financial Statistics*, BIS *Locational banking statistics*, and the World Bank *World Development Indicators*. The EM data is divided into a few key categories: trilemma factors, international financial linkages, domestic banking sector characteristics, and other domestic macro-financial measures and controls. In addition, we also obtain data for the US from FRED (Federal Reserve Bank of St. Louis), and information on options-implied volatility on the S&P500 (VIX) from Chicago Board Options Exchange (CBOE). A comprehensive list of variables and their data sources is shown in table B.2.

Our main variable of interest throughout is the *overnight interbank rate*. Wherever possible, we use the middle value, but in case this is not available, we proxy using the next best alternative, such as the offered rate, central bank's policy rate, or 1 and 15 day middle

[8]The MSCI index countries are: Argentina, Brazil, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Malaysia, Mexico, Poland, Peru, Philippines, Qatar, Russia, South Africa, South Korea, Thailand, Taiwan, Turkey, and UAE.

[9]Specifically, we drop Argentina, Egypt, Russia, South Korea, Taiwan and Qatar in the panel analysis.

rates (see appendix B). We use US daily effective federal funds rate (FFR) from FRED to measure of US liquidity events.[10] The FFR is proxied by the Wu and Xia (2016) shadow rate while it is at the zero lower bound. For Europe, we use the Euro Overnight Index Average (EONIA).

A correlation heat map for the entire sample is provided in figure 6, which shows that with the possible exception of few countries, most emerging economy rates have a high, positive correlation with US and EU liquidity conditions.

3.1 Wholesale funding reliance measure

Wholesale funding is characterised by two important features – it includes claims held by intermediaries on other intermediaries, as well as liabilities to foreign creditors (Shin and Shin, 2011). During financial upswings, when retail deposits grow more slowly, banks typically end up relying more heavily on non-core or wholesale funding to finance themselves (Shin and Shin, 2011). Even though these banks may end up benefiting from diversification in their funding sources during normal times, they are also significantly more susceptible to liquidity collapses during crises (Huang and Ratnovski, 2011).

Therefore, a priori we expect that if countries with higher reliance on wholesale funding are perceived to be riskier, then they will have higher interbank rates on average; however, any diversification benefits could instead be reflected in lower interbank rates. Importantly, this relationship is likely to be different during normal and crisis times.

There are several definitions of wholesale funding reliance used in the literature. For example, Chung *et al.* (2015) use proprietary data on non-financial corporate deposits from the IMF. However, as in Brokmann (2012), it can also be defined simply as the share of non retail deposit funding (equation 1). For this measure, *total retail deposits* are defined as the difference between *total deposits* and *deposits from other banks* (which are also considered as wholesale funds). Therefore, a higher value of W_i^b below indicates greater reliance on wholesale funding for bank i at any given point in time:

$$W_i^b = 1 - \frac{\text{Total retail deposits}_i}{\text{Total liabilities}_i} \tag{1}$$

Raddatz (2010) also uses a similar definition (equation 2), but transforms it to correct for certain data issues, such as banks with zero deposits, as well as outliers. The interpretation changes accordingly: a higher value of W_i^r (i.e. less negative) indicates a higher reliance on wholesale funding for bank i at any given point in time:

$$W_i^r = -log(1 + [\frac{\text{Total retail deposits}_i}{\text{Total liabilities}_i}]) \tag{2}$$

We modify the Raddatz (2010) measure further to obtain the aggregate dependence on wholesale funding for each country-quarter. We weigh the inner fraction of equation 2

[10] Available online at https://fred.stlouisfed.org/series/DFF.

by the relative size of bank i in the total assets of country c in quarter q as shown in equation 3:[11]

$$W^m_{c,q} = -log(1 + \Sigma_{i,q}[(\frac{\text{Assets of bank}_{i,c,q}}{\text{Total assets}_{c,q}} \times \frac{\text{Total retail deposits}_{i,c,q}}{\text{Total liabilities}_{i,c,q}})]) \quad (3)$$

In order to create this variable, we use three series from Bankscope: total liabilities & equity, total deposits & short-term funding, and deposits from banks. We have data on a total of 2179 banks from our sample, but coverage varies from country to country.[12] Table 2 gives some bank-country-quarter wise descriptives. The average bank in the entire sample uses funding to the tune of USD$26 billion, of which approximately 34% is wholesale. The largest bank in the entire dataset is The Industrial and Commercial Bank of China, with a balance sheet size of USD$3.7 trillion in 2015 Q2. Aggregating over all banks for each country-quarter pair demonstrates variation in relative sizes of the banking systems, with China, and to some extent South Africa, as outliers (table 3).

After creating all three measures of wholesale funding, we check the correlation between them. As table 4 shows, the correlation between our modified measure in equation 3 and the other two is very high and significant (0.85 and 0.84, respectively). Therefore, we rely only our modified measure in the ensuing analysis.

We can demonstrate what the distribution of our wholesale funding measure should look like by taking two extreme cases. The first is where the country finances its liabilities entirely with retail deposits. It is therefore **not** reliant on wholesale funding at all, making the lower-bound of the measure as follows (equation 4):

$$W^m_{c,q} = -log(1 + 1) = -0.69 \quad (4)$$

On the other hand, a country which finances its liabilities completely with wholesale funding (and has zero retail deposits), would make the upper-bound of the measure:

$$W^m_{c,q} = -log(1 + 0) = 0 \quad (5)$$

Therefore, the higher or *less* negative the measure, the more reliant the country is on wholesale funding. The density plot of our measure, bound between 0 and -0.69, is shown in figure 8.

The median country's banking sector, based on our modified measure (table 1), finances itself with 32% of wholesale funding, and the rest with deposit funding. The middle 50% of EMs (based on the interquartile range) fund their liabilities with between 23% to 41% of wholesale funding. In figure 7, we show the total number of quarters where a particular country in our sample has above median wholesale funding (the median is taken over all countries in the sample each quarter). It is primarily dominated by Latin-American countries such as Brazil, Colombia, and Mexico, whilst Asian emerging economies such

[11] We continue to use *log* at the country level as the inner fraction of equation 3 is skewed. However, constructing the measure without *log* yields qualitatively similar baseline results, although with larger magnitudes.

[12] The highest number of banks in our sample are in Russia, and the lowest in Hungary.

as China and India are at the other end of the spectrum. Figures A.1 and A.2 show the two-quarter rolling averages of our wholesale funding measure for a select few countries.

4 Do interbank rates respond to global liquidity shocks?

In order to use money market rates to study transmission, we first collate a list of important global liquidity shocks since 2007. Given their dominant role as reserve currencies and in invoicing (figure 5), we expect that liquidity shocks to USD and EUR are particularly important for emerging economies. We therefore include some key monetary policy announcements between 2007 and 2018 by the Federal Reserve (Fed) and European Central Bank (ECB), which would have altered funding costs in these currencies, building on work by Fawley and Neely (2013). For the Fed, we use the published minutes of Board meetings to ascertain whether there was a change in the target for the Federal Funds Rate, or any other unconventional monetary policy announcement to target the yield curve indirectly. For the ECB, we use monetary policy announcements mentioned in the monthly and economic bulletins.

A few other important events are also included: collapse of Lehman Brothers in September 2008, Ben Bernanke's speech in May 2013 that indicated a possible liftoff from QE and led to the "taper tantrum", as well as Mario Draghi's "whatever it takes" speech in July 2012. We only consider announcement dates. Detailed dates and sources are available in appendix C for the Fed (table C.1) and ECB (table C.2). Our sample spans the GFC and post-crisis period, and as a result, most of the events in our sample are positive liquidity events. The exceptions include, for example, the ECB in March 2007, June 2007, July 2008 and October 2008, and the Fed in December 2016 and all through 2017-18.

Our hypotheses are that

Hypothesis 1 (H1): *Interbank rates respond significantly when there is a global liquidity event.*
Hypothesis 2 (H2): *Interbank rates respond by more than short-term bond yields in response to a global liquidity event.*

We use daily data on interbank rates for 23 EMs to conduct our event study, using an event window of 5 days before and after the event itself. Using a small window around the event date reduces concerns that other variables are driving the results (see, for example, Gürkaynak and Wright, 2013). We first convert interbank rates to basis points, then calculate the daily percent change for each country. We rebase changes on the first day of the event window to 0 to ease comparison. Next, we cumulate the changes, by country, over the 10 day window. Finally, we use bootstrap inference, i.e. random resampling with replacement, to obtain a distribution of the sample's average cumulative changes per day. In this way, we can also construct the 95% confidence intervals. Our event study is similar in construction to the one by Patnaik *et al.* (2013b).

For robustness, we also use a longer window of ± 10 days around the event, and present some results with this window in appendix A. The longer window is motivated by the fact that most EMs in our sample have capital controls and managed exchange rates, which may slow down speed of transmission.

4.1 Baseline results

We start by pooling all our events, differentiating them only by whether they are positive (implying a loosening) or negative (implying a tightening), and calculating the average cumulative percent change in the interbank rate for all countries. An average positive liquidity event ($N = 25$) in the US reduces the federal funds rate (FFR) by up to 30% over a 10 day window (left panel, figure 10). Symmetrically, a negative event ($N = 9$) increases FFR by 30% (right panel, figure 10).[13]

Figure 11 shows the cumulative percentage effect on all EM interbank rates for all types of events by both Fed and ECB, plus the Lehman bankruptcy. There is a significant and immediate effect of both types of shocks, although the magnitude is higher for negative events – roughly +3% within four days on average across the entire sample and all 15 events – than for positive shocks, where the average effect translates to an average decline of 1.5% over five days and 53 events.[14] All event studies graphs have 95% confidence intervals.

To give a sense of the economic magnitude, the average interbank rate for all EMs in our sample between January 2007 and December 2009 was 6.27%. The above result implies that a positive liquidity shock would be associated with an average reduction of roughly 9 basis points, to 6.18%. On the other hand, the average interbank rate just before Fed liftoff from QE in December 2013 was 4.75%, and the results above suggest than this negative liquidity event would have been linked to an increase in the average rate by $10bps$ within 5 days. Using a ± 10 day window in figure A.4 does not change the results, but it does show that the average effects persist and become more pronounced over a longer window around the event, still more for negative events than positive ones (+5% vs. -1.5% respectively). Therefore, evidence so far seems to suggest an asymmetric transmission, even though our sample of negative events is much smaller.[15]

We find that these pooled results mask the sometimes very large effects of individual events. In addition, our aggregate results might mask the anticipation effects of some events, therefore, we study in detail a few true "surprise" events. In figure 12 we show the effect of three specific events on the interbank rates of all EMs. We observe that the Lehman bankruptcy (a negative shock) and QE1 announcement (a positive shock) in the first panel had significant effects, whereas similar to the rest of the literature, we find a somewhat muted effect of QE2 in our event window. The Lehman shock increased interbank rates on average by 6%, whereas the announcement of QE1 added up to a cumulative effect of -8% across all EMs within a couple of days. The day before QE1 was announced, the average interbank rate across the sample was 7.83% and the announcement would have translated to an overall reduction by $63bps$ to 7.20% within two days. We also look at Mario Draghi's *"whatever it takes"* speech in 2012 (figure A.3), and find no significant effects over 5 or 10 day windows, only over 20 days.

We compare the results on money market rates with those on bond yields in figure 13.

[13] The wide confidence interval for the negative liquidity graph is driven by the few events.

[14] Dropping the Lehman event does not change the results.

[15] As a robustness check, we also try to estimate liquidity shocks using the $0.5 - 99.5\%$ tails of the LIBOR distribution. We pick up 24 positive and negative events each, both of which are strongly dominated by 2008; however, most positive events by this definition tend to be those when LIBOR has fallen back down after a spike. Running event studies with this gives us similar results as before with negative events, but not with positive events.

We focus on short-term bond yields (i.e. bonds with tenor of 3 years or lesser) because they are more liquid and more comparable to overnight money markets.[16] The effects of liquidity shocks are muted when we use benchmark bond yields as our measure of interest rate conditions, i.e. we find no effects of positive or negative events on short-term bond yields. This implies that using bond yields to measure spillovers from advanced economies may lead to researchers severely underestimating transmission effects. This also seems to support the claim that interbank markets and banks, rather than bond markets, are the vectors that transmit global financial conditions to EMs.

4.2 Heterogeneity by pull factors

We hypothesise that the strength of transmission of global liquidity events is dependent on a few country specific *pull* factors. The first one is capital account openness – by definition, a country with a relatively more open capital account has stronger linkages with the rest of the world and is more susceptible to waves of capital flows. We calculate the average capital openness for our sample of countries over the entire time period using two indices, Chinn and Ito (2006) and Lane and Milesi-Ferretti (2003, 2007), and then split our sample using the median.[17] In figures 14 and 15, we estimate the average cumulative percent change in interbank rates for above and below median capital account open countries, respectively.

For countries with relatively more open capital accounts, we see that while their interbank rates fall in response to positive liquidity shocks, the response to negative liquidity shocks is consistently more pronounced. This result is robust to using the Chinn-Ito index in panel (a) of figure 14, Lane-Milesi-Ferretti index in panel (b), or the countries selected by both indices as the most open in panel (c).

On the other hand, results for countries with relatively closed capital accounts are mixed. Evidence in panel (a) of figure 14 seems to indicate that transmission of positive shocks is more significant for these countries as compared to negative shocks. However, this observation is not robust to using the Lane-Milesi-Ferretti index in panel (b), where we see the opposite.

The asymmetric result with respect to capital account openness is also echoed when we study countries with above (below) median share of foreign banks in figure A.5. In panel (a), countries which have higher presence of foreign banks tend to respond significantly to negative shocks (+6%), but marginally to positive ones. We see that the opposite is true in panel (b) for countries which have lesser foreign banking sector assets.

[16] In practice, for each country, we use the shortest tenors available.

[17] The Chinn and Ito (2006) index, $KAOPEN$, is a *de jure* index of capital account openness, based on restrictions on cross-border financial transactions reported in IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). Information on a host of variables which are presented as binary variables in the AREAER is converted into indices using principal components analysis. According to this measure, Australia was ranked among the most open economies in 2016, whilst Venezuela was the least open. Data is available online at `http://web.pdx.edu/~ito/Readme_kaopen2016.pdf`. Lane and Milesi-Ferretti (2003, 2007) is an index of *de facto* capital account openness, and defined as the ratio of the sum of international assets and liabilities to overall GDP. Since it is a continuous measure, it often shows different rankings of most open to least open countries (see, for example, Ma and McCauley, 2013).

The next *pull* factor we investigate is wholesale funding. In a similar vein, we split our sample into countries that are above and below median wholesale funding. The results in figure 16 are in line with our priors: countries which rely more on wholesale funding tend to respond more to liquidity shocks than do countries with lesser reliance on wholesale funding. Moreover, when we follow the results from figure 7 and drop Malaysia and Taiwan from the sample of countries with above-median wholesale funding, the results are even stronger. As in the other event study results presented above, we find that there is persistence of effects and our results are even stronger at the ±10 day window.

In this section, we found evidence that interbank rates of EMs with relatively closed capital accounts are nevertheless significantly responsive to international liquidity events. This is true whether we choose individual dates of well-known shocks (Lehman bankruptcy, QE announcements, "whatever it takes", etc.) or whether we aggregate over all events.

5 Econometric methodology and panel results

We now exploit the panel dimension of the data to show that the relationship between EM interbank rates and liquidity shocks also stands when we control explicitly for country specific fundamentals. We are also interested in estimating the link between interbank rates and pull factors associated with domestic banking microstructure. To do this, we estimate a micro-aggregated macro panel shown in equation 6:

$$\begin{aligned}\Delta ibkr_{c,q} = \alpha_c + \boldsymbol{\beta_A}\ wf_{c,q-1} + \boldsymbol{\beta_B}\ fb_{c,q-1} + \\ \beta_1\ gr_{c,q-1} + \beta_2\ pi_{c,q-1} + \beta_3\ res_{c,q-1} + \beta_4\ stock_{c,q-1} + \\ \beta_5\ bf_{c,q-1} + \beta_6\ ids_{c,q-1} + \beta_7\ expdep_{c,q-1} + \\ \eta_1\ \Delta i^*_{q-1} + \eta_2 D^{QE}_{q-1} + \eta_3 D^{TT}_{q-1} + + \eta_4\ vix_{q-1} + \epsilon_{c,q}\end{aligned} \tag{6}$$

for country c in quarter q. We collapse all data to quarterly and lag all regressors by one quarter. The βs refer to all domestic variables and ηs to foreign variables (US and Europe). Variables reported in equation 6 are grouped by the category to which they belong, based on table B.2. The dependent variable, $\Delta ibkr_{c,q}$, is the change in the quarterly level of the overnight money market interest rate for country c from quarter $q-1$ to q. The main explanatory variables are weighted reliance on wholesale funding (wf) and share of foreign bank assets (fb).

The other controls are: GDP growth rate (gr), inflation rate (pi), growth of central bank reserves (res), growth of the domestic stock market index ($stock$), growth of cross-border banking flows (bf), growth of IDS issuances by non-financial corporates (ids), depreciation of the domestic currency vis-a-vis the USD ($expdep$), quarterly change in the foreign interest rate (Δi^*), and growth of VIX (vix). As before, there are two foreign rates that are our main measures of liquidity shocks in core countries: the effective federal funds rate $\Delta effr$ for the US and $\Delta eonia$ for Europe.

Additionally, in some specifications we replace Δi^* with growth in the monetary base ($mbase^*$). D^{QE*} is a dummy variable which take value 1 if that quarter has an uncon-

ventional monetary policy action by the Fed and value 0 if not (similarly for the ECB).[18] D^{TT*} refers similarly to the taper tantrum.

Our main hypotheses are as follows:

Hypothesis 3 (H3): *β_A, the coefficient on wholesale funding should be positive.*
Hypothesis 4 (H4): *β_B, the coefficient on share of foreign bank assets should be positive.*
Hypothesis 5 (H5): *η_1, the coefficient on foreign interbank rate, should be positive, while η_5, the coefficient on growth rate of monetary base (wherever used), should be negative. η_2 and η_3, coefficients on QE and taper tantrum dummies, should be negative and positive respectively.*

As discussed in more detail in section 5.1, we expect the following signs on the other coefficients: $\beta_1^{gr} > 0$, $\beta_2^{pi} > 0$, $\beta_3^{res} < 0$, $\beta_4^{stock} < 0$, $\beta_5^{bf} > 0$, $\beta_6^{idsnfc} > 0$, $\beta_7^{expdep} > 0$, and $\eta_4^{vix} > 0$.

Note that since we have foreign variables like US shadow rate and monetary base which are common to all countries in our sample, we cannot include time fixed effects. However, we do include time fixed effects wherever these time-varying country-invariant variables are excluded from the equation. This is indicated in each regression table.

5.1 Explanatory variables

Our main explanatory variables of interest are *exposure to wholesale funding* (discussed in detail in section 3.1), *share of foreign banks*, and *reserve requirements*. Here we discuss the latter two.

We are interested in the role played by **foreign banks** in the transmission of global shocks to EM interbank rates. In general, emerging economies do not have large share of foreign banks, with a range of 0% (South Korea in 1997-2000) to 88% (Hungary in 2006) in our sample and an average of 38% (table 1), but the question is whether the presence of foreign banks *exacerbates*, or *mitigates* the propagation of a shock to the parent company, such that happened during the crisis. This extends the framework of Cetorelli and Goldberg (2012b) by arguing that in times of crises, foreign banks in various emerging economies may compete for parents' resources, or be required to transfer resources internally to their parent bank. Therefore, assuming that foreign banks are set up in EMs with less stringent regulations and controls (comparing, for example, Hungary with India or China), we can expect higher transmission to domestic conditions in these countries. Additionally, how is this compounded further by a greater reliance on wholesale funding? We expect a priori that the estimated coefficients on both share of foreign banks by itself, and its interaction with wholesale funding, will be *positive*. This hypothesis links well also to our event study where we find similar results.

Another key variable of interest is **reserve requirements**, and the role played by it in mitigating the effects of global liquidity shocks. Our data on legal reserve requirements (RR) for emerging economies comes from Federico *et al.* (2014).[19] Though the dataset

[18] Please see tables C.1 and C.2 in the appendix for details on the events
[19] The dataset is available online at http://go.worldbank.org/D7JYE3SLS0.

contains information on RR by maturity and currency, to maximise coverage we use the simple average of all RR arrangements in the country in that quarter. The main benefit of this dataset – though its coverage is only until 2015 Q4 – is that we can observe the actual percentage requirement, rather than just knowing whether the requirement was changed. The average EM has a 9% requirement over the sample, with the maximum (40%) being in Peru (which reflects the fact that requirements on foreign currency deposits are much higher than those on local currency deposits).

We also include other controls in our regressions. We use **international debt securities issuances** by non-financial corporates (NFC) by nationality (following Shin, 2013 and Hoggarth *et al.*, 2016). If NFCs issue securities in countries with low interest rates and use the funds there, we should expect an *insignificant* coefficient. On the other hand, they may deposit these funds raised abroad in their local banks, thereby acting as "surrogate intermediaries" (Shin and Zhao, 2013; Avdjiev *et al.*, 2014; Caballero *et al.*, 2015). Doing so would infuse the local banking system with liquidity. We should then expect a *negative* coefficient. **Exchange rate depreciation** is calculated as quarterly return on the currency, instead of averaging over the entire quarter (which might cancel out the variation). Depreciation of the domestic currency increases the foreign currency debt liabilities of domestic banks and firms. This increases domestic liquidity risk. Therefore, we expect the coefficient to be *positive*.

Data on **cross-border banking flows** is also from BIS locational statistics.[20] We expect there to be a *positive* coefficient on this variable (Blank and Buch, 2010; Bruno and Shin, 2015b; Hoggarth *et al.*, 2016). **Stock market capitalisation** captures market source of funds, and **reserves** proxy the funds available from the central bank, due to which we expect a *negative* coefficient on both. **Real growth** of GDP controls for the general macroeconomic environment.

As our proxy of USD liquidity events, we have the US Wu and Xia (2016) **shadow rate** and US **monetary base** (*positive* coefficient), as well as **QE dummies** (*negative* coefficient) and **taper tantrum dummy** (*positive* coefficient). For EUR liquidity events, we use the overnight interbank rate, $\Delta eonia$. We also have a measure of global risk – **VIX** – of which we expect a *positive* effect: an increase in global risk should increase risk aversion and the premium that banks charge to lend at very short maturities, thereby increasing the interbank rates.

The descriptive statistics are shown in table 1. The average emerging economy in our sample has an interbank rate of about 5.7%, faces depreciation pressure on its currency, has a relatively closed capital account, above median wholesale funding, and regularly uses reserve requirements.

Table 5 shows a condensed correlation matrix. Looking at wholesale funding (raw), which is simply the fraction inside the $-log$ in equation 3, shows that an *increase* in the share of retail funding in total liabilities leads to a *decrease* in interbank rates. The final measure, with the $-log$ transformation as in Raddatz (2010), has the opposite sign and is interpretable as follows: an increase in reliance on wholesale funding (which makes the measure less negative) *increases* interbank rates.

[20] It is the total claims on the domestic banking system from all foreign banks and counter-parties in all currencies.

5.2 Baseline results

Table 6 presents the baseline results for US liquidity events and table 7 for European events. As expected, country fundamentals (GDP growth and stock market growth) and trilemma factors (expected currency depreciation) are significant with the correct signs. The key banking microstructure variables, wf, the weighted share of wholesale funding, and fb, the share of foreign banks, are positive and significant, even when we include a full set of country and time fixed effects in columns (1)-(5) of table 6 and column (1) of table 7.

From column (5) in table 6, holding all else constant, we find that a one standard deviation increase in wholesale funding of an emerging economy's banking sector is linked to a 10 *basis points* increase in the interbank rate ($\Delta ibkr$) on average over an entire quarter.[21] These results are robust to excluding China and South Africa, which have larger banking sectors as compared to the rest of the sample. Similarly, a one standard deviation increase in the share of foreign banks is associated with an average increase in the interbank rate by 34 *bps*. We also find that as global risk aversion increases (vix), the average marginal effect of wholesale funding reliance (or foreign bank share) on the interbank rate increases.[22]

In table 6, we find that change in the US effective federal funds rate ($\Delta effr$) has the correct sign and implies an average increase in interbank rates by roughly 3 *bps*, although it is not significant. Using the growth rate of US monetary base as an alternate measure of liquidity shocks works in the expected direction: it is significant and negative. The coefficient on monetary base in column (9) shows that a one standard deviation increase in US monetary base growth – a positive liquidity event – translates to an interbank rate reduction of 0.14 standard deviations on average, about 12.6 *bps*.

The significance of monetary base (and not the federal funds rate) potentially reflects the fact that the monetary base is a better indicator of liquidity shocks originating in the US in the post-GFC world. However, it may also be the one-time massive increase in monetary base due to QE1 in 2008 that drives these results – when we winsorize growth of monetary base at 1% in the right tail, we obtain the same negative coefficient, but it becomes marginally insignificant. Although in following specifications we use this winsorized version of monetary base, it is indicative of the significant effects that large, unanticipated shocks to funding conditions in core economies can have on emerging ones.

Interestingly, we find stronger results of EU liquidity events in table 7. From column (3), we estimate that a one standard deviation increase in EONIA increases the average interbank rate by 20 *bps*. It may simply be that this result is driven by the European EMs in the sample; however, in column (5) we show that this is not the case.

In table 8, we split the sample into pre and post crisis (with crisis defined as starting from 2007Q2). From columns (4)-(6), we can see that most of our results are being driven

[21] The magnitude of the effect from column (6) without any time fixed effects is roughly similar, 15 *basis points*. Using the raw wholesale funding measure (i.e. without the *log*) gives qualitatively similar values in the range of $15 - 22$ *basis points*.

[22] We investigate this through the interaction term $vix \times wf$ and $vix \times fb$ with time fixed effects. The interaction coefficients are positive for both variables, implying that the overall marginal effect of both variables on the interbank rate is even higher when global risk aversion (vix) is increasing. However, the interaction is significant at 90% confidence level only for wholesale funding. The results are available on request.

by the post-2007Q2 period.[23] Although all the country level variables pre-crisis have the correct signs, they are usually not significant.[24] Interacting only the foreign variables with the post-crisis dummy in table A.1 also does not change the results either.

Next we explore the question of which countries drive our results on wholesale funding. A priori, based on figure 7, we expect the results to be strongest for Latin American countries and weakest for Asian ones. Therefore, we interact our two variables of interest – wholesale funding and foreign bank share – with a geography dummy in table 9. The results are in line with our hypothesis. Asian emerging economy interbank rates respond to wholesale funding to a significantly lesser degree than other countries. While the same story is true for share of foreign banks as well, its interactions are not significant.[25] This result is robust to using other US monetary base growth as well as EONIA.[26]

We are also interested in the interaction effect of wholesale funding and foreign banks. There is some evidence that foreign banks and wholesale funding are mutually reinforcing, in that their interaction is positive, however, it is not significant at 90% confidence levels. The average marginal effect of share of foreign banks at different levels of wholesale funding is shown in figure A.6.

5.3 Channels of transmission of liquidity events

We have so far shown that there is a positive and significant relationship between wholesale funding reliance and share of foreign banks with the change in interbank rates in emerging economies. We now discuss the role played by these channels in transmission of liquidity shocks. To do this, we modify equation 6 by adding interaction terms that capture the average marginal effect of these channels: $\beta_{6A}\ wf_{c,q-1} \times \Delta i^*_{q-1}$ and $\beta_{6B}\ fb_{c,q-1} \times \Delta i^*_{q-1}$. As previously, our measures of $i*_{q-1}$ are the effective federal funds rate $\Delta effr$ for the US and $\Delta eonia$ for Europe.

Columns (1) and (2) in table 10 show the interaction effects of wholesale funding with the change in effective FFR ($\Delta effr$) and the (winsorized) growth rate in US monetary base ($\Delta mbasew$), while column (3) shows the interaction with $\Delta eonia$. Columns (4) - (6) are organised similarly, but show the interaction with share of foreign banks. The base variables (wf and fb) are both positive and significant. Surprisingly, both US FFR and its interaction with wholesale funding are insignificant, with the incorrect sign (negative instead of positive). US monetary base growth and EONIA are also insignificant but at least both its base variable and interaction have the correct negative sign. In columns (4) - (6), all the foreign variables by themselves enter with the correct signs, and all but EONIA are insignificant. The interaction terms with foreign banks is also negative (albeit insignificant), which is not consistent with our hypothesis.

[23] We also check the sensitivity of these results to timing of the "post-crisis" dummy. Therefore, we re-estimate the model using alternate definitions by allowing the crisis to start alternatively from: 2006Q2, 2008Q2, and 2008Q3. Our results are robust to all these definitions, with one key difference: wholesale funding and share of foreign banks become significantly different from 0 in the "pre-crisis" periods if we use any of the 2008 definitions.

[24] This may also be because there is more missing data on wholesale funding for the early part of the sample.

[25] Pooling all non-Asian countries into one category, and then comparing them to Asian countries yields the same results.

[26] These results are not reported here in the interest of brevity.

We hypothesise that there may be some heterogeneity in the estimated relationships post-crisis. Therefore, we estimate a triple interaction $wf_{c,q-1} \times \Delta i^*_{q-1} \times$ Post2007Q2, where *Post2007Q2* is a dummy variable that takes value 1 after 2007 Q3, as before. The results are presented in table 11. In order to interpret the triple interaction, we can re-write a simplified version of our model, focusing on FFR, denoted as Δeffr_{q-1} below:

$$\begin{aligned}\Delta i_{c,q} =&\beta_1\ \text{wf}_{c,q-1} + \beta_2\ \text{Post2007Q2} + \beta_3\ \Delta\text{effr}_{q-1} + \\ &\beta_4\ \text{wf}_{c,q-1} \times \text{Post2007Q2} + \\ &\beta_5\ \text{Post2007Q2} \times \Delta\text{effr}_{q-1} + \beta_6\ \text{wf}_{c,q-1} \times \Delta\text{effr}_{q-1} \\ &\beta_7\ \text{wf}_{c,q-1} \times \text{Post2007Q2} \times \Delta\text{effr}_{q-1} + \epsilon_{c,q}\end{aligned} \tag{7}$$

We can then derive the following, using coefficients from column (1) of table 11:

$$\frac{\partial(\Delta\text{ibkr})}{\partial\Delta\text{effr}} = \beta_3 + \beta_5\text{Post2007Q2} + \beta_6\Delta\text{wf} + \beta_7\text{Post2007Q2} \times \Delta\text{wf}$$

$$\left[\frac{\partial(\Delta ibkr)}{\partial\Delta effr}\right]_{Post2007Q2=0} = -1.31 - 2.91(wf) \tag{8}$$

$$\begin{aligned}\left[\frac{\partial(\Delta ibkr)}{\partial\Delta effr}\right]_{Post2007Q2=1} &= -1.31 + 1.51 + (wf)(3.27 - 2.91) \\ &= 0.2 + 0.36(wf)\end{aligned} \tag{9}$$

From equation 8, we can surmise that in the pre-crisis period, for a given increase in the effective federal funds rate ($\Delta effr$), which is a liquidity tightening event, given average levels of wholesale funding, translates to a reduction in EM interbank rates (and the opposite for a liquidity loosening event). This opposite sign is fairly robust through most sample cuts. However, it reverses in the post-crisis period (equation 9), when we obtain the correct signs on the slopes. That is, in the post crisis period, an increase in the federal funds rate is linked to increases in interbank rates as wholesale funding dependence of a country increases.[27]

To allow for easier interpretation, we plot the adjusted predictions of our dependent variable, $\Delta ibkr$, in the post-crisis period for different levels of wholesale funding in figure 17. Note that the x-axis is increasing in wholesale funding reliance, so -0.69 on the left hand represents no reliance on wholesale funding, while a value of 0 represents complete reliance on wholesale funding. Although both our interest rate series are continuous, for the purposes of this graph, we choose the maximum level of change in federal funds rate and EONIA, i.e. $\Delta effr$ and $\Delta eonia$ observable in our sample. Therefore, panel (a) tells us that if the federal funds rate increases by $+0.88$ in the post-crisis period, interbank rates significantly increase as wholesale funding reliance within a country increases. Similarly for panel (b), where the change in *eonia* is set at $+0.68$.

[27] We obtain the same results on the interactions when we add time fixed effects, but we cannot then estimate coefficients on the base variables.

We find that as a country increases its reliance on wholesale funding in the post-crisis period, its interbank rates respond more to a negative liquidity event in either the US or the EU.

5.4 Policy options: The role for reserve requirements

We have shown so far that emerging economies with higher reliance on wholesale funding and higher share of foreign banks tend to have higher interbank rates, and the interaction of these two features may act to amplify the effect on interbank rates. In addition, a negative liquidity event at least in the Post-2007Q2 period, has implied greater transmission to these emerging economy's interbank rates if they have higher reliance on wholesale funding.

Recent surveys of macro-prudential measures by various researchers find mixed evidence on the credit cycle dampening effects of RR (Claessens *et al.*, 2013; Cerutti *et al.*, 2017). The domestic banking structure and regulatory arbitrage matters significantly for the effectiveness of RR (Galati and Moessner, 2018). Foreign banks in EMs have been known to tap into global interbank funding/ parent funds when faced with a hike in RR. Fendoğlu (2017) finds that in an EM context, RR is the only lender based macro-prudential tool which is effective.[28] In our case, when we are looking at transmission in money markets, reserve requirements provide a simple policy tool to reduce (increase) interbank rates by releasing (absorbing) liquidity to (from) the banking system (Hoffmann and Loeffler, 2017).

Therefore, we modify the estimated equation as follows:

$$\begin{aligned}\Delta ibkr_{c,q} = \alpha_c + \beta_A\ wholesale\ funding_{c,q-1} + \beta_B\ foreign\ bank\ share_{c,q-1} + \\ \boldsymbol{\beta_C}\ reserve\ req_{c,q-1} + \boldsymbol{\beta_D}\ wholesale\ funding \times reserve\ req_{c,q-1} + \\ \beta\ X_{c,q-1} + \eta\ F_{q-1} + \epsilon_{c,q}\end{aligned} \tag{10}$$

where $X_{c,q-1}$ are all the controls discussed before, and F_{q-1} are the foreign variables. Our hypothesis can be formally stated as:

Hypothesis 6 (H6): *Reserve requirements help in slowing down international monetary policy transmission to EM interbank rates, but this depends on the level of wholesale funding reliance. Consequently, β_C and β_D in equation 10 should both be positive.*

Therefore, we study the interaction of wholesale funding (wf) and reserve requirements (rrf): $\phi wf_{c,q-1} \times rrf_{c,q-1}$. The results are shown in table 12. Columns (1)-(3) contain US and EU variables ($\Delta effr$, $\Delta mbasew$, $\Delta eonia$ respectively) and therefore only contain country fixed effects; in column (4) we drop country-invariant variables and include time fixed effects. The coefficient on rrf shows that as reserve requirements are increased, and excess liquidity is absorbed in the local banking sector, the interbank rate in country

[28] Agénor *et al.* (2018) formalises this mechanism with a DSGE model in a small open economy setting where retail deposits, interbank funding and central bank liquidity are imperfect substitutes and finds that a credit based RR rule is optimal in mitigating spillovers from global monetary policy conditions, especially when the central bank uses a managed floating exchange rate regime as its nominal anchor

c increases, as expected. The interaction with wholesale funding has a positive sign throughout, and it is consistently significant at 5% confidence levels.

We plot the overall effect of the interaction term $rrf \times wf$ in figure 18. In panel (a), we show the effect on interbank rates of reducing reserve requirements from 0.4 (the maximum in our sample) to 0 (the minimum) given average wholesale funding. The key take-way is that given marginal change in wholesale funding, a country that cuts its reserve requirements can reduce its interbank rates. In panel (b), we show what happens to interbank rates when a country moves from almost no wholesale funding (-0.65) to full reliance on wholesale funding (0), conditional on a marginal change in level of reserve requirements. For a country with increasing reliance on wholesale funding, a given marginal change in reserve requirements has a larger (dampening) effect on interbank rates.

Taken altogether, we have provided some evidence to support the popularity of reserve requirements in emerging economies, especially as they have increased their reliance on wholesale funding and witnessed greater transmission of liquidity shocks to their local banking sectors in the post-crisis period. As we showed in the previous section, increased reliance on wholesale funding is associated with higher interbank rates. However, the central bank can improve local liquidity conditions by reducing reserve requirements. The result is in line with Altunbas *et al.* (2018), who find that banks with higher reliance on wholesale funding respond more strongly to changes in macro-prudential measures.

6 Future work and conclusions

In this paper, our main focus has been to show that interbank rates in emerging economies co-move with international liquidity shocks. The first piece of evidence we provided was an event study that showed that both positive and negative events by the Fed and ECB have the expected effects on interbank rates of a sample of 23 EMs. Further, their magnitudes can often be very large when the shock is large and unanticipated, as some of the unconventional monetary policy announcements in the post-crisis period have been. They are significantly more responsive than short-term bond yields.

Using panel data, we show that even after collapsing data down to quarterly frequency and controlling for country fundamentals and unobservables, international funding shocks transmit to interbank rates. In transmission of shocks, push and pull factors are important but so are the liquidity conditions of the local country banking sector. Specifically, we find that increasing reliance on wholesale funding or foreign banks is associated with higher interbank rates. The relationship between interbank rates and wholesale funding is particularly pronounced for non-Asian EMs and is stronger after the global financial crisis. Other country variables of importance are GDP growth, depreciation of the currency, stock market performance, and cross-border banking flows, but we cannot find any evidence on the role played by international debt issuances by non-financial corporates. Next, we show that in the post-crisis period, transmission of negative liquidity shocks to interbank rates is higher when countries increase their wholesale funding reliance. Finally, we provide evidence that reserve requirements can be used by EM central banks to mitigate some of the effects of international shocks on their local liquidity conditions.

If this work can be extended to a larger historical panel, it could potentially provide some answers to why reserve requirements have been such a popular tool in emerging markets for both monetary policy and macro-prudential objectives. This work also gives some impetus to EMs adopting Basel III norms with the liquidity coverage ratio (LCR) and net stable funding ratio (NSFR) providing similar protection from global funding shocks. It would be interesting to see in the future, going forward whether LCR/NSFR reduce the utilisation of reserve requirements as a macro-prudential tool in EMs. As a future work agenda, we hope to analyse other lender-based macro-prudential measures which affect bank liquidity positions and their effectiveness in mitigating cross-border interbank transmission. There might also be some interesting implicit policy cooperation or "bubble thy neighbour effects" in the use of these instruments (Forbes *et al.*, 2016). We also want to explore interaction effects by using *interacted panel VAR* methodology developed by Towbin and Weber (2012) to examine the effect on real lending in EMs due to global funding shocks. The analysis in the paper would be greatly strengthened by making the money-market microstructure richer by controlling for the presence of EM non-bank financial entities. As of now, data constraints prevent us from examining the liquidity co-dependence of banks and non-bank financial entities; to that extent, we may be missing one element of the story. In larger, financially developed EMs, like China in Q3 2015 or India in Q4 2018, their non-bank financial sector has been the cause of EM-wide liquidity stress (Ehlers *et al.*, 2018; Acharya *et al.*, 2013). This is another potential channel of contagion as non-banking financial sectors in EMs grow and become more internationalised.

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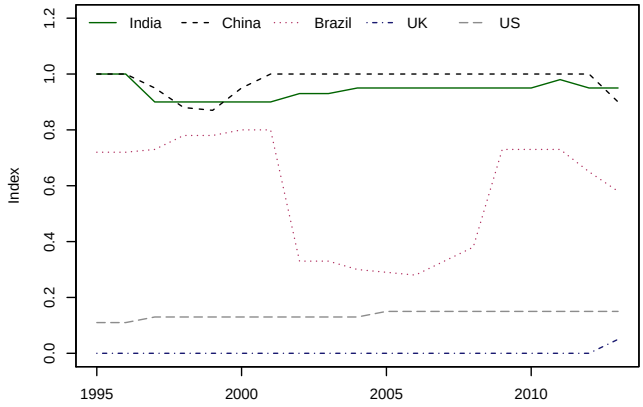
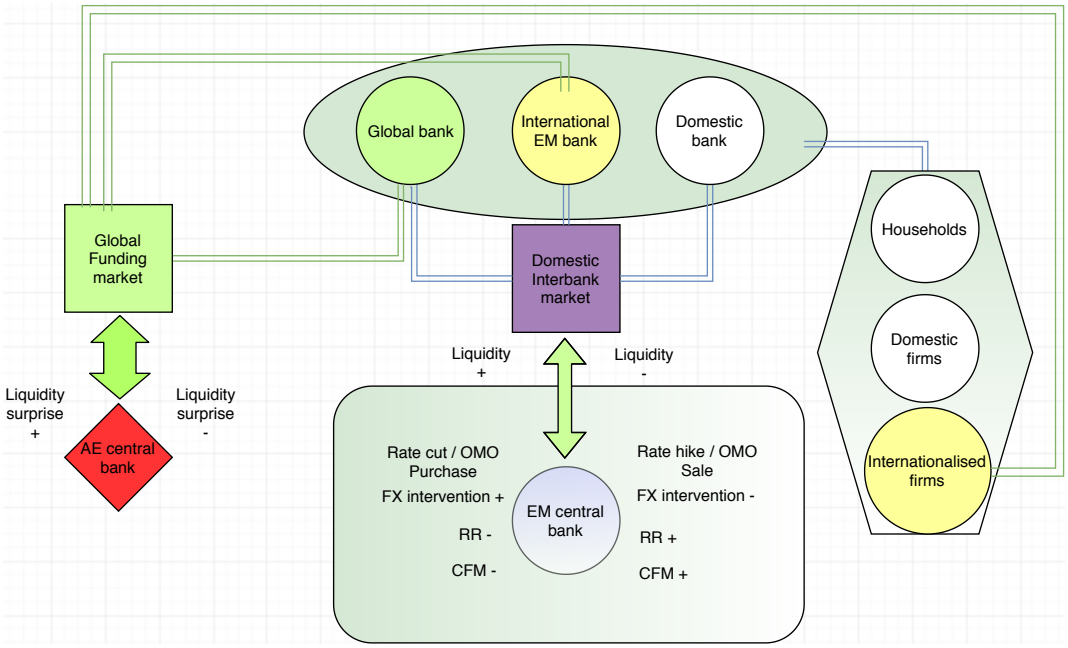
Figures and tables

Figure 1: Comparison of capital controls



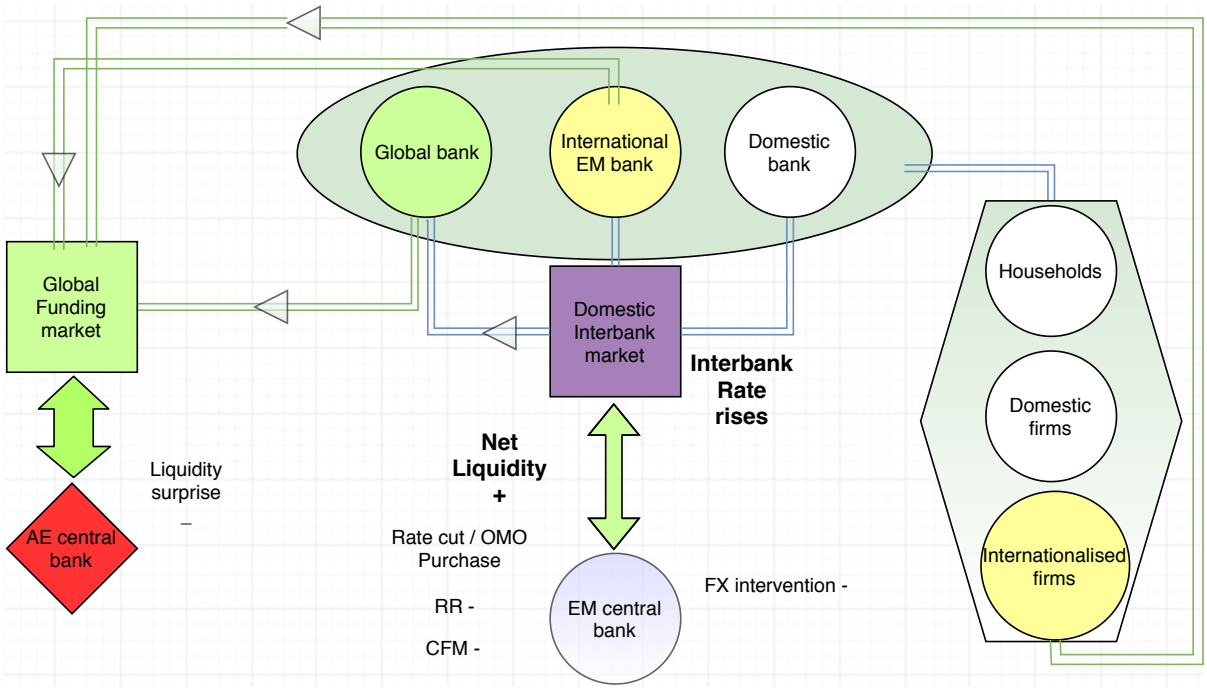
Note: The graph shows an index of capital controls between 0 and 1 (with 1 showing high number of capital control rules in any given year), adapted from Fernandez *et al.* (2016).

Figure 2: Transmission mechanism: An overview



Note: This figure provides an overview of the transmission mechanism discussed in this paper.

Figure 3: Transmission mechanism: An example of a negative liquidity shock



Note: This figure provides an example of how the transmission mechanism is expected to adjust in the presence of a negative foreign liquidity shock.

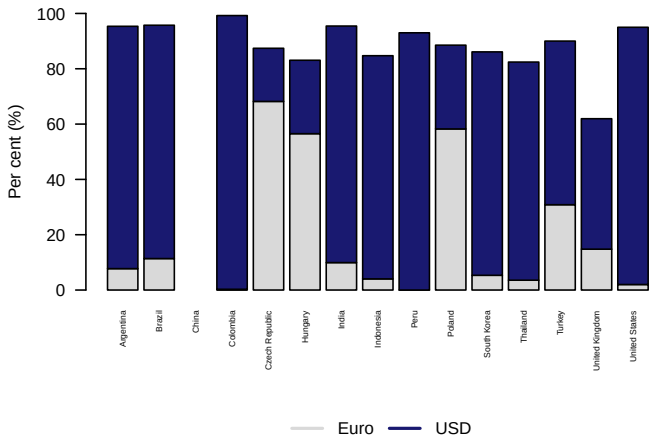
Figure 4: Drivers of EM capital flows

Type	Driver	Portfolio Equity	Portfolio Debt	Banking Flows
Push	Global risk aversion	−	−	−
	Mature economy interest rates	−	−	-
	Mature economy output growth	+	+	?
Pull	Domestic output growth	+	+	+
	Asset return indicators	+	+	+
	Country risk indicators	-	-	−

+	Strong evidence for positive relationship
+	Some evidence for positive relationship
?	Mixed evidence, no clear relationship
-	Some evidence for negative relationship
−	Strong evidence for negative relationship

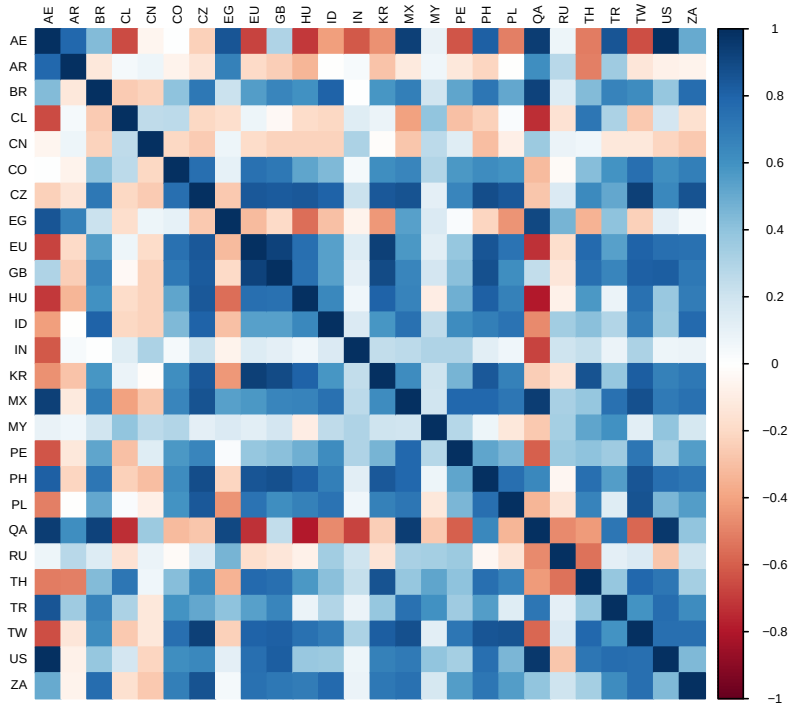
Note: This figure is reproduced from figure 1 in Koepke (2019), who summarise evidence on push and pull factors after an analysis of 34 field papers from 1996-2016.

Figure 5: Share of EUR and USD in import invoicing, 1999-2014 average



Note: This graph shows the dominant invoicing currency for the imports of major EMs using data obtained from Gopinath (2016). It is the average share of invoicing done in Euro (EUR) and US dollar (USD) between 1999 and 2014. There is no data reported for China, or for the share of invoicing i EUR for Peru.

Figure 6: Descriptive statistics: Money market correlation matrix



Note: This is the correlation matrix of money market rates for all EMs and 3 advanced country central banks: Fed (US), ECB (EU), and Bank of England (GB). Country codes are as follows: AE (United Arab Emirates), AR (Argentina), BR (Brazil), CL (Chile), CN (China), CO (Colombia), CZ (Czech Republic), EG (Egypt), EU (Europe), GB (Great Britain), HU (Hungary), ID (Indonesia), IN (India), KR (South Korea), MX (Mexico), MY (Malaysia), PE (Peru), PH (Phillippines), PL (Poland), QA (Qatar), RU (Russia), TH (Thailand), TR (Turkey), TW (Taiwan), US (USA), and ZA (South Africa).

Table 1: Descriptive statistics: All data

Variable	N	Mean	SD	P25	P50	P75	P95
Panel A: Country variables							
Interbank rates (pp)	882.00	5.73	4.01	2.98	4.78	7.58	14.06
Δ interbank rates (pp)	882.00	-0.10	0.91	-0.30	-0.00	0.18	1.09
Reserves exc. gold (growth, %)	882.00	2.56	6.06	-0.79	2.20	5.73	12.54
Real GDP growth (%)	881.00	4.66	3.71	2.62	4.68	6.67	10.89
Inflation (pp)	882.00	4.49	2.97	2.52	4.07	6.21	9.84
Cross-border banking flows (growth, %)	882.00	2.22	11.98	-5.15	1.88	8.62	21.09
Stock market index (growth, %)	882.00	2.04	9.79	-2.81	2.38	7.69	16.96
Reliance on wholesale funding ($-log(1+x)$)	882.00	-0.49	0.11	-0.57	-0.52	-0.46	-0.20
Reliance on wholesale funding (raw)	882.00	0.64	0.17	0.58	0.68	0.76	0.82
Depreciation	872.00	0.44	5.98	-2.52	0.00	2.82	10.98
Share of foreign banks $(0-1)$	882.00	0.41	0.22	0.24	0.39	0.57	0.80
IDS issuances by NFCs (growth, %)	882.00	3.58	16.11	-0.82	1.08	6.05	20.68
Reserve requirements (pp)	769.00	0.09	0.09	0.03	0.06	0.13	0.28
Chinn-Ito capital account openness $(0-1)$	882.00	0.52	0.31	0.17	0.45	0.70	1.00
Panel B: US/EU variables							
US Effective federal funds rate	882.00	0.69	2.43	-1.26	0.37	2.00	5.25
Δ US FFR	882.00	-0.07	0.46	-0.29	-0.04	0.09	0.61
EONIA	882.00	1.47	1.58	0.09	0.77	2.94	4.25
Δ EONIA	882.00	-0.07	0.35	-0.08	-0.01	0.06	0.37
Monetary base (log)	882.00	0.50	0.69	-0.21	0.69	1.22	1.38
Monetary base ($diff\ log$)	882.00	0.03	0.08	0.00	0.01	0.03	0.15
QE dummy	882.00	0.22	0.41	0	0	0	1
Taper tantrum dummy	882.00	0.02	0.13	0	0	0	0
VIX (growth, %)	882.00	-0.66	22.89	-15.20	-3.71	9.24	45.25

Note: The table presents descriptive statistics for all the variables. Variable definitions, sources, and frequencies are in table B.2.

Table 2: Descriptive statistics for Bankscope data: Overall

Statistic	Obs.	Mean	St. Dev.	Min	Max
Total assets	24,775	25.457	160.598	0.000	3,666.791
Total liabilities & equity	24,751	25.481	160.674	0.000	3,666.791
Total deposits & short-term funding	24,374	20.226	140.041	0.000	3,161.355
Deposits from banks	19,788	3.496	22.764	−0.0003	497.629
All data in billion USD.					

Note: This table presents overall descriptives for the Bankscope data used to construct the wholesale funding reliance measure.

Table 3: Descriptive statistics for Bankscope data: Country-quarter wise

Country	Total assets	Total liabilities	Total deposits	Total bank deposits
CN	312.58	312.58	280.04	49.03
ZA	19.04	19.04	25.75	4.32
KR	14.44	14.44	4.63	1.14
PL	13.72	13.72	10.52	1.27
QA	11.84	11.84	9.03	1.85
TW	10.90	11.36	9.17	1.53
CZ	10.17	10.17	12.20	1.08
IN	8.34	8.34	5.95	0.16
HU	8.25	8.25	6.05	1.20
TH	5.11	5.20	4.65	0.59
PH	3.68	3.68	2.63	0.06
EG	3.61	3.61	3.07	0.11
TR	3.29	3.29	2.32	0.61
MY	2.85	2.85	2.12	0.57
CL	1.79	1.79	1.17	0.41
BR	1.77	1.77	0.72	0.06
ID	1.73	1.76	1.28	0.07
PE	1.28	1.28	0.83	0.16
MX	1.09	1.09	0.50	0.70
AR	0.42	0.42	0.24	0.02
CO	0.34	0.34	0.20	0.02
RU	0.09	0.09	0.04	0.00
All data in billion USD.				

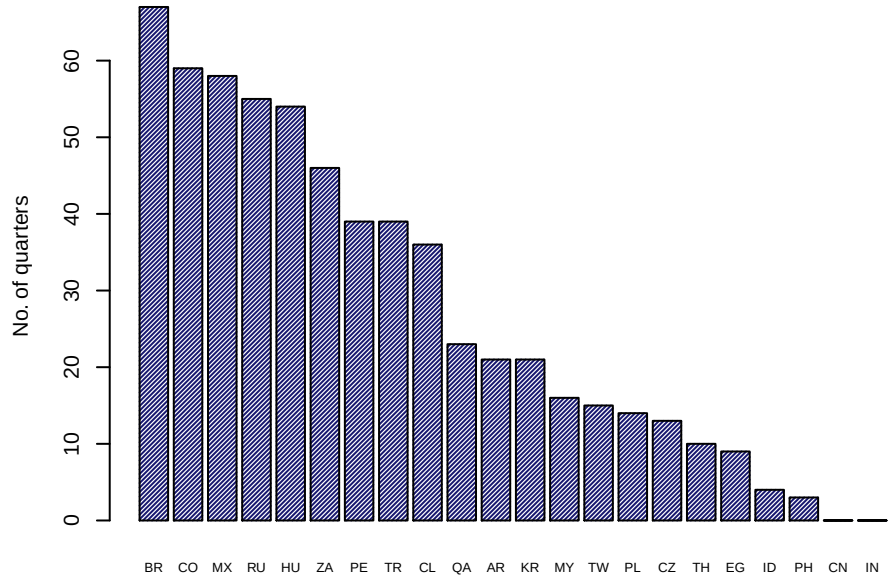
Note: Country codes are as follows: AE (United Arab Emirates), AR (Argentina), BR (Brazil), CL (Chile), CN (China), CO (Colombia), CZ (Czech Republic), EG (Egypt), EU (Europe), GB (Great Britain), HU (Hungary), ID (Indonesia), IN (India), KR (South Korea), MX (Mexico), MY (Malaysia), PE (Peru), PH (Phillippines), PL (Poland), QA (Qatar), RU (Russia), TH (Thailand), TR (Turkey), TW (Taiwan), US (USA), and ZA (South Africa).

Table 4: Correlation between measures of wholesale funding

	Raddatz	Brokmann
Raddatz		
Brokmann	1.00***	
Modified Raddatz	0.85***	0.84***
*** p<0.01, ** p<0.05, * p<0.1		

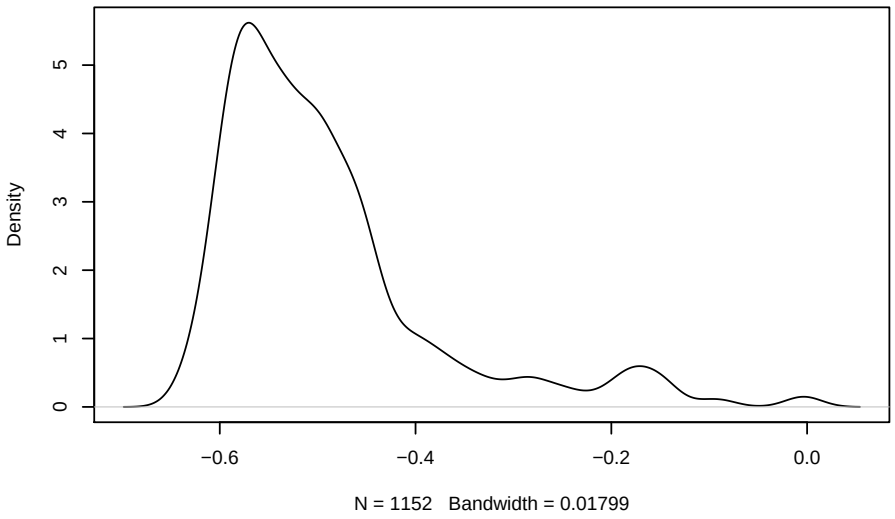
Note: The table presents simple correlations with the three measures of wholesale funding: one from Brokmann (equation 1), from Raddatz (equation 2), and our modified version of the Raddatz measure (equation 3).

Figure 7: No. of above-median wholesale funding quarters per country



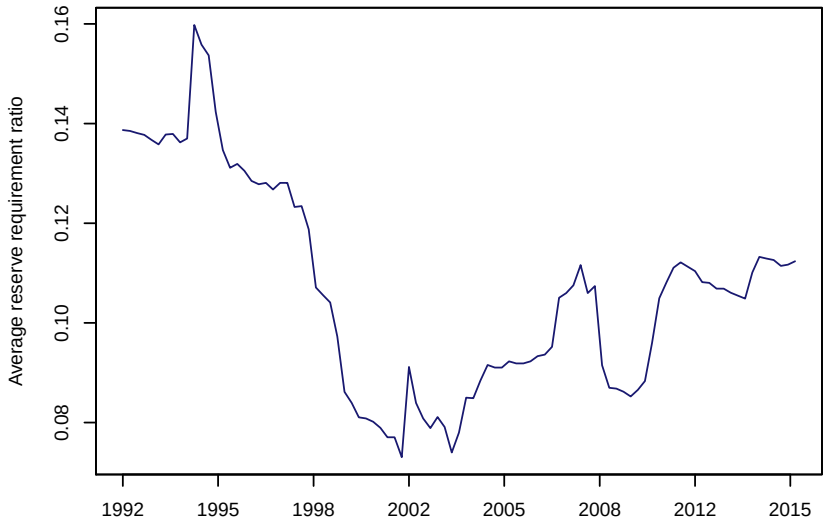
Note: This figure shows the total number of quarters (out of 72) where a particular country in our sample has above median wholesale funding. The median is calculated for all EMs per quarter (the overall median is −0.48). The number of countries with above median WF increases from 5 in 2000 Q2 to 10 in 2008 Q4, and to 11 in 2016 Q4. Country codes are as follows: AR (Argentina), BR (Brazil), CL (Chile), CN (China), CO (Colombia), CZ (Czech Republic), EG (Egypt), HU (Hungary), ID (Indonesia), IN (India), KR (South Korea), MX (Mexico), MY (Malaysia), PE (Peru), PH (Phillippines), PL (Poland), QA (Qatar), RU (Russia), TH (Thailand), TR (Turkey), TW (Taiwan), and ZA (South Africa).

Figure 8: Density plot: Modified wholesale funding measure



Note: This figure shows the density plot of our modified wholesale funding measure. As shown in the paper, it is bound between −0.69 (no reliance on wholesale funding) and 0 (complete reliance on wholesale funding).

Figure 9: Average reserve requirement ratio



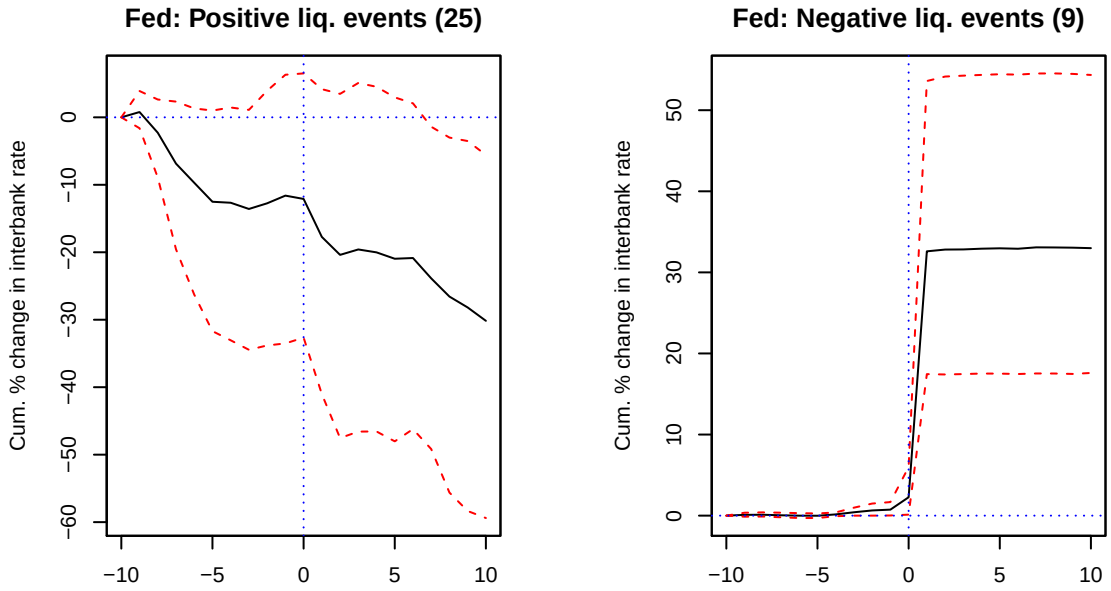
Note: The figure shows the average reserve requirement ratio for 17 countries using data from Federico *et al.* (2014) from 1992 to 2015. The countries from the MSCI EM index which are not covered in this measure are Egypt, Qatar, Russia, South Korea, Taiwan, and UAE.

Table 5: Descriptives statistics: Small correlation matrix

Interbank rates (pp)	
Gr.Reserves (%)	0.00
Real GDP growth (%)	−0.14****
Inflation (pp)	0.67****
Stock market index (growth, %)	−0.08*
Depreciation	0.02
IDS issuances by NFCs (growth, %)	−0.06*
Cross-border banking flows (growth, %)	−0.03
Reserve requirements	0.26****
Reliance on wholesale funding: Raw	−0.15****
Reliance on wholesale funding: -Log	0.14****
Share of foreign banks (0-1)	−0.08**
Chinn Ito capital account openness	−0.13****
US effective FFR	0.26****
US Wu-Xia shadow rate	0.32****
EONIA	0.40****
US Monetary Base	−0.36****
VIX (growth, %)	0.07*
QE dummy	−0.13****
TT dummy	−0.05
EU dummy	−0.11****

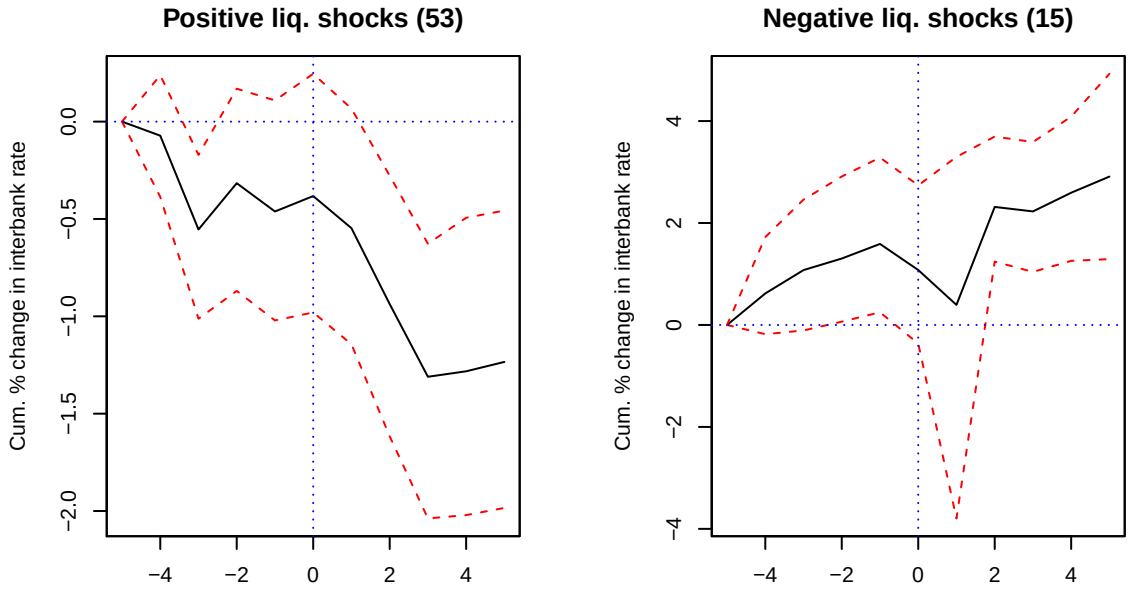
Note: The table presents a small correlation matrix for our variables of interest. Descriptive statistics are presented in table 1, and variable definitions, sources, and frequencies are in table B.2.

Figure 10: Event study: Cumulative % change in FFR, 2007-2018



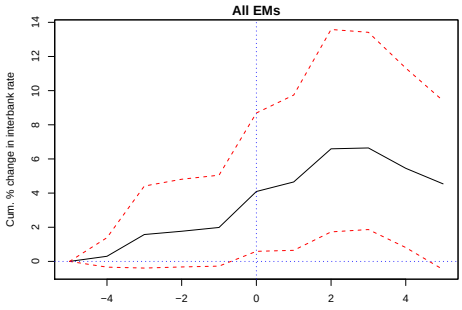
Note: This graph provides a cumulative percent change in US interbank rate (federal funds rate) all (a) positive and (b) negative liquidity events by the Fed 2007 - 2018, plus the Lehman bankruptcy in 2008. Number of events are shown in the titles. The events are shown in greater detail in appendix C.

Figure 11: Event study: Cumulative % change in EM interbank rate, 2007-2018

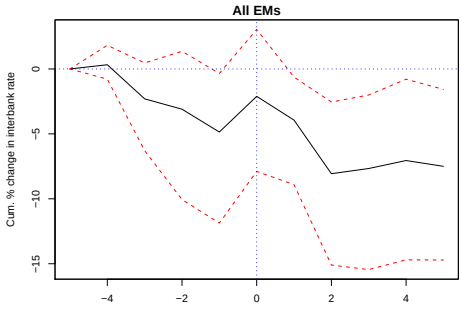


Note: This graph shows the cumulative percent change in EM interbank rate in response to all (a) positive and (b) negative liquidity events by the Fed & ECB between 2007 - 2018, plus the Lehman bankruptcy in 2008. The sample consists of 23 emerging economies from the MSCI EM index, and events are shown in greater detail in appendix C.

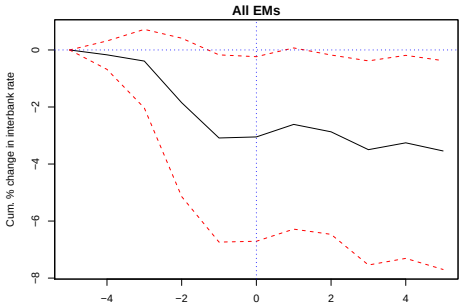
Figure 12: Event study: Effect of "surprise" events



(a) Lehman bankruptcy



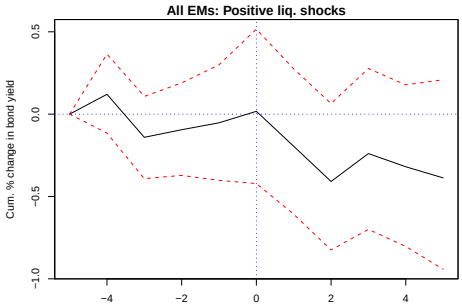
(b) QE1

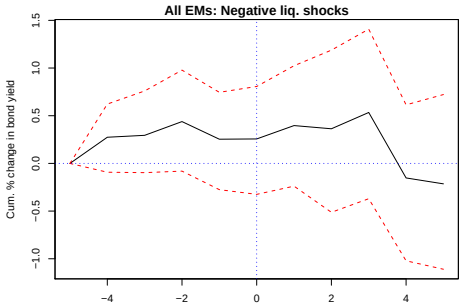


(c) QE2

Note: This table shows the cumulative effect of 3 "surprise" events on the interbank rates of all EMs, within a ±5 day window. The three events are: (a) Lehman bankruptcy (15.09.2008), (b) first quantitative easing (QE) announcement by the Fed (25.11.2008), and (c) second QE announcement by the Fed (03.11.2010). The sample consists of 23 emerging economies from the MSCI EM index, and events are shown in greater detail in appendix C.

Figure 13: Event study: Baseline event study with bond yields

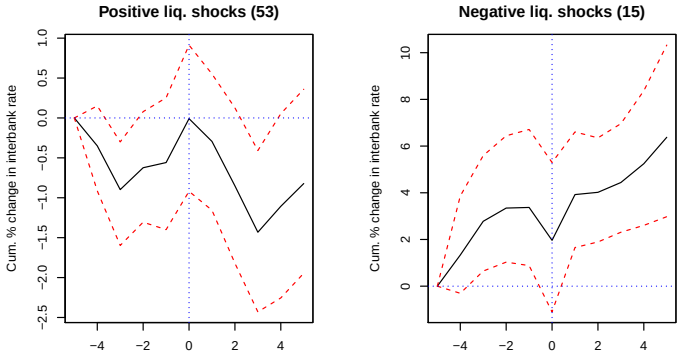




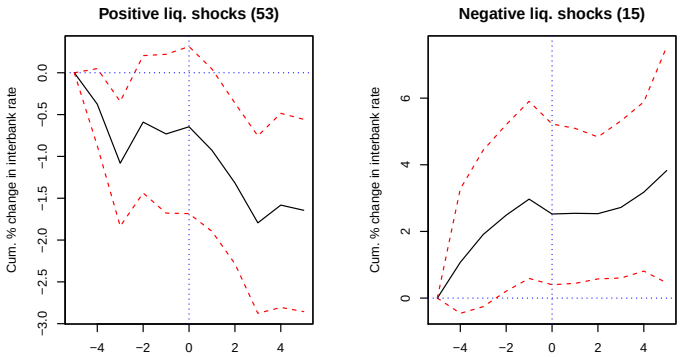
Note: This table shows the cumulative percent change in bond yields for all events. Short-term bond yields are on bonds with tenor of 3 years or lesser The sample consists of 23 emerging economies from the MSCI EM index, and events are shown in greater detail in appendix C.

Figure 14: Event study: Above-median capital account openness

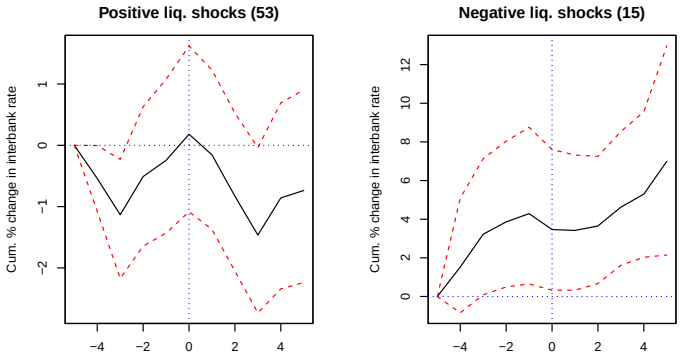
Panel (a): Chinn-Ito index, 11 countries



Panel (b): Lane-Milesi-Feretti index, 11 countries



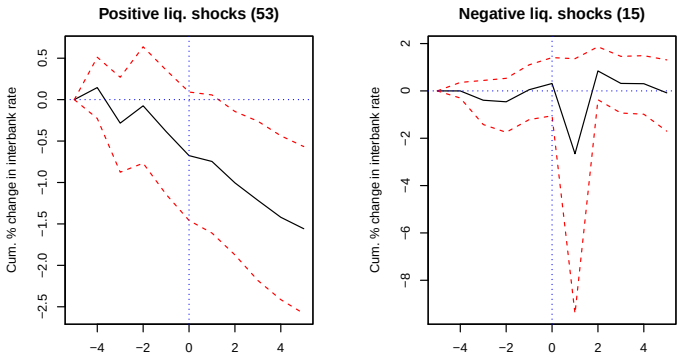
Panel (c): Both indices, 7 countries



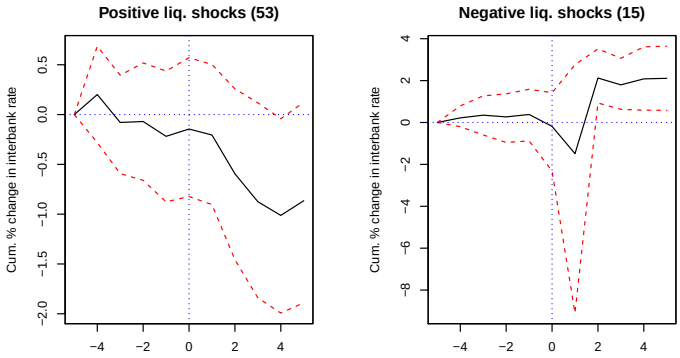
Note: We split our sample of countries into above-median capital account openness using the Chinn and Ito (2006) index in panel (a) and Lane and Milesi-Ferretti (2003, 2007) index in panel (b). The countries in panel (a) are United Arab Emirates, Czech Republic, Hungary, Indonesia, South Korea, Mexico, Malaysia, Peru, Qatar, Russia, and Thailand. Countries in panel (b) are Chile, Czech Republic, Hungary, Korea, Malaysia, Poland, Qatar, Russia, South Africa, Taiwan, and Thailand. Panel (c) is the subset of countries selected as most open by both indices. The full sample consists of 23 emerging economies from the MSCI EM index, and events are shown in greater detail in appendix C.

Figure 15: Event study: Below-median capital account openness

Panel (a): Chinn-Ito index, 11 countries



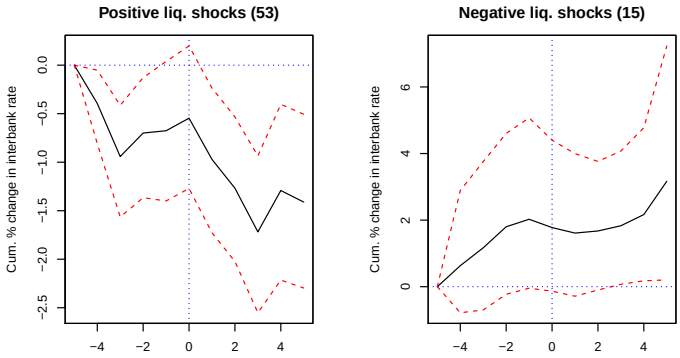
Panel (b): Lane-Milesi-Feretti index, 11 countries



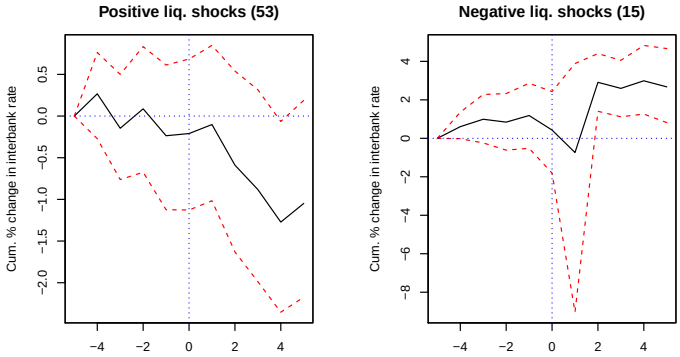
Note: We split our sample of countries into below-median capital account openness using the Chinn and Ito (2006) index in panel (a) and Lane and Milesi-Ferretti (2003, 2007) index in panel (b). The countries in panel (a) are Argentina, Brazil, Chile, China, Colombia, Egypt, India, Philippines, Poland, Turkey, Taiwan, and South Africa. Countries in panel (b) are United Arab Emirates, Argentina, Brazil, China, Colombia, Egypt, Indonesia, India, Mexico, Peru, Phillippines, Turkey. The solid line is the average effect, while the dashed lines around it are the 95% confidence intervals. The full sample consists of 23 emerging economies from the MSCI EM index, and events are shown in greater detail in appendix C.

Figure 16: Event study: Split sample by wholesale funding reliance

Panel (a): Above-median wholesale funding reliance, 11 countries



Panel (b): Below-median wholesale funding reliance, 11 countries



Note: We split our sample of countries into above and below-median wholesale funding reliance in panel (a) and (b) respectively. The countries in panel (a) are Brazil, Chile, Colombia, Hungary, Mexico, Malaysia, Peru, Russia, Turkey, Taiwan, and South Africa. Countries in panel (b) are UAE, Argentina, China, Czech Republic, Egypt, Indonesia, India, South Korea, Philippines, Poland, Qatar, and Thailand. The full sample consists of 23 emerging economies from the MSCI EM index, and events are shown in greater detail in appendix C.

Table 6: Baseline results: US events

	Dependent variable: $\Delta ibkr_{it}$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$res_{c,q-1}$	-0.01*	-0.01	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00	-0.00
	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.007)	(0.006)
$gr_{c,q-1}$	0.07***	0.08***	0.08***	0.08***	0.08***	0.10***	0.10***	0.11***	0.10***
	(0.015)	(0.015)	(0.016)	(0.016)	(0.016)	(0.016)	(0.014)	(0.016)	(0.013)
$pi_{c,q-1}$	-0.01	-0.00	0.00	0.00	0.00	-0.01	-0.01	-0.01	-0.01
	(0.018)	(0.021)	(0.021)	(0.021)	(0.021)	(0.019)	(0.017)	(0.019)	(0.018)
$bf_{c,q-1}$	0.00	0.01*	0.01	0.00	0.00	0.01**	0.01**	0.01**	0.01**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$stock_{c,q-1}$	-0.02***	-0.02***	-0.01***	-0.01***	-0.01***	0.00	-0.01*	-0.00	-0.01**
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.007)	(0.004)	(0.004)	(0.004)
$wf_{c,q-1}$		0.68*	0.63	0.80*	0.80*	1.22***	1.26***	1.27***	1.32***
		(0.398)	(0.412)	(0.432)	(0.430)	(0.341)	(0.371)	(0.346)	(0.367)
$expdep_{c,q-1}$			0.02**	0.02**	0.02**	0.01	0.01**	0.01**	0.01**
			(0.007)	(0.007)	(0.007)	(0.006)	(0.005)	(0.006)	(0.005)
$fb_{c,q-1}$				1.41*	1.42*	2.31***	2.19***	2.51***	2.42***
				(0.846)	(0.847)	(0.650)	(0.641)	(0.650)	(0.649)
$ids_{c,q-1}$					-0.00	0.00	0.00	0.00	0.00
					(0.002)	(0.001)	(0.002)	(0.002)	(0.002)
$\Delta effr_{q-1}$						0.09		0.05	
						(0.068)		(0.069)	
$vix_{c,q-1}$							-0.00**	-0.01*	-0.00**
							(0.002)	(0.003)	(0.002)
$\Delta mbase_{q-1}$							-2.02***		-1.91***
							(0.594)		(0.523)
$USQE$								-0.20**	-0.15*
								(0.098)	(0.079)
$USTT$								0.11	0.22***
								(0.074)	(0.074)
Observations	1,002	868	858	858	858	858	858	858	858
No of EMs	16	16	16	16	16	16	16	16	16
R-squared	0.227	0.265	0.271	0.274	0.274	0.142	0.174	0.162	0.180
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	No	No	No	No

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is $\Delta ibkr$, or change in average quarterly interbank rate (calculated from daily data). The other variables are: GDP growth (gr), inflation (pi), growth of central bank reserves excluding gold (res), growth of cross-border banking flows (bf), growth of the domestic stock market index ($stock$), depreciation of the domestic currency ($expdep$), share of foreign bank assets (fb), growth of international debt securities issuances by non-financial corporates ($idsnfc$), quarterly change in the foreign interest rate (Δi^*), and growth of VIX (vix). wf is our measure of wholesale funding and the main parameter of interest (more in section 3.1). We also include a few country-invariant variables of interest, four of which capture US dollar funding conditions: the effective federal funds rate that is proxied by Wu and Xia (2016) shadow rate while at the zero lower bound ($\Delta effr$), growth of monetary base ($\Delta mbase$), and dummies for the QE announcements and 2013 "taper tantrum" announcement. All explanatory variables are included with 1 quarter lag. There are 16 EMs included in the regression, with roughly 61 quarters of data each. Columns (1)-(5) contain full set of country and time fixed effects. Standard errors are clustered on time.

Table 7: Baseline results: EU events

	Dependent variable: $\Delta ibkr_{it}$				
	(1)	(2)	(3)	(4)	(5)
	All	All	All	All	Ex. EU
$res_{c,q-1}$	-0.01	-0.01	-0.00	-0.00	-0.01
	(0.007)	(0.007)	(0.007)	(0.007)	(0.010)
$gr_{c,q-1}$	0.08***	0.08***	0.08***	0.08***	0.08***
	(0.016)	(0.014)	(0.015)	(0.015)	(0.019)
$pi_{c,q-1}$	0.00	-0.01	-0.01	-0.01	-0.00
	(0.021)	(0.017)	(0.017)	(0.017)	(0.022)
$bf_{c,q-1}$	0.00	0.00	0.01*	0.01*	0.01*
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$stock_{c,q-1}$	-0.01***	0.00	-0.01	-0.01	-0.00
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)
$wf_{c,q-1}$	0.80*	1.10***	1.07***	1.09***	0.92**
	(0.430)	(0.347)	(0.358)	(0.358)	(0.406)
$expdep_{c,q-1}$	0.02**	0.01	0.01**	0.01**	0.02***
	(0.007)	(0.006)	(0.006)	(0.006)	(0.008)
$fb_{c,q-1}$	1.42*	2.21***	2.07***	2.18***	2.13***
	(0.847)	(0.682)	(0.683)	(0.706)	(0.790)
$ids_{c,q-1}$	-0.00	0.00	0.00	0.00	-0.00
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
$\Delta eonia_{q-1}$		0.52***	0.55***	0.54***	0.62***
		(0.150)	(0.140)	(0.137)	(0.174)
vix_{q-1}			-0.01***	-0.01***	-0.01***
			(0.002)	(0.002)	(0.002)
$EUQE$				-0.04	-0.04
				(0.057)	(0.071)
Observations	858	858	858	858	634
No of EMs	16	16	16	16	12
R-squared	0.274	0.169	0.186	0.186	0.186
Country FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	No	No	No	No

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is $\Delta ibkr$, or change in average quarterly interbank rate (calculated from daily data). The other variables are: GDP growth (gr), inflation (pi), growth of central bank reserves excluding gold (res), growth of cross-border banking flows (bf), growth of the domestic stock market index ($stock$), depreciation of the domestic currency ($expdep$), share of foreign bank assets (fb), growth of international debt securities issuances by non-financial corporates ($idsnfc$), quarterly change in the foreign interest rate (Δi^*), and growth of VIX (vix). wf is our measure of wholesale funding and the main parameter of interest (more in section 3.1). In columns (2)-(4), we include two variables to capture Euro funding conditions: the quarterly change in EONIA rate ($\Delta eonia$), and dummies for the ECB's QE announcements. All explanatory variables are included with 1 quarter lag. There are 16 EMs included in the regression, with roughly 61 quarters of data each. Column (1) contains full set of country and time fixed effects. Standard errors are clustered on time.

Table 8: Additional results I: Split sample, pre and post crisis

	Dependent variable: $\Delta ibkr_{it}$					
	(1) Pre-2007Q2	(2) Pre-2007Q2	(3) Pre-2007Q2	(4) Post-2007Q2	(5) Post-2007Q2	(6) Post-2007Q2
$res_{c,q-1}$	-0.01	-0.01	-0.01	-0.00	-0.00	-0.00
	(0.017)	(0.015)	(0.017)	(0.007)	(0.007)	(0.007)
$gr_{c,q-1}$	0.17**	0.20***	0.18**	0.11***	0.10***	0.07***
	(0.067)	(0.072)	(0.071)	(0.018)	(0.012)	(0.011)
$pi_{c,q-1}$	-0.01	-0.01	-0.01	0.01	0.01	0.02
	(0.058)	(0.058)	(0.057)	(0.017)	(0.015)	(0.014)
$bf_{c,q-1}$	0.02**	0.02**	0.02**	0.00	0.00	0.00
	(0.007)	(0.007)	(0.007)	(0.002)	(0.002)	(0.002)
$stock_{c,q-1}$	-0.02	-0.02*	-0.01	0.00	-0.00	-0.00
	(0.011)	(0.009)	(0.009)	(0.005)	(0.004)	(0.005)
$wf_{c,q-1}$	1.89	1.75	1.86	0.94**	0.93***	0.53
	(1.275)	(1.296)	(1.274)	(0.356)	(0.338)	(0.351)
$expdep_{c,q-1}$	0.01	0.02	0.01	0.01**	0.01**	0.01**
	(0.017)	(0.017)	(0.017)	(0.006)	(0.005)	(0.006)
$fb_{c,q-1}$	2.43	2.34	2.45	4.76***	3.85***	2.83***
	(3.734)	(3.807)	(3.798)	(1.244)	(1.108)	(1.008)
$ids_{c,q-1}$	-0.01	-0.01	-0.01	0.00	0.00	0.00
	(0.006)	(0.006)	(0.006)	(0.002)	(0.002)	(0.002)
$vix_{c,q-1}$	-0.00	-0.00	-0.00	-0.00	-0.00	-0.01***
	(0.005)	(0.005)	(0.005)	(0.003)	(0.002)	(0.002)
$\Delta effr_{q-1}$	0.07			0.02		
	(0.172)			(0.073)		
$\Delta mbase_{c,q-1}$		16.81			-1.99***	
		(15.048)			(0.709)	
$\Delta eonia_{q-1}$			-0.03			0.69***
			(0.452)			(0.074)
Observations	244	244	244	614	614	614
R-squared	0.153	0.161	0.153	0.224	0.258	0.302
No of EMs	16	16	16	16	16	16
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	No	No	No
US QE dummies	No	No	No	Yes	Yes	No
US TT dummies	No	No	No	Yes	Yes	No
EU QE dummies	No	No	No	No	No	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is $\Delta ibkr$, or change in average quarterly interbank rate (calculated from daily data). The other variables are: GDP growth (gr), inflation (pi), growth of central bank reserves excluding gold (res), growth of cross-border banking flows (bf), growth of the domestic stock market index ($stock$), depreciation of the domestic currency ($expdep$), share of foreign bank assets (fb), growth of international debt securities issuances by non-financial corporates ($idsnfc$), quarterly change in the foreign interest rate (Δi^*), and growth of VIX (vix). wf is our measure of wholesale funding and the main parameter of interest (more in section 3.1). $Pre2007Q2$ is the period from 2000 Q1 till 2007 Q2; $Post2007Q2$ is the period from 2007 Q3 to 2016 Q4. For US dollar funding conditions, we use change in effective federal funds rate ($\Delta effr$), and growth rate of monetary base ($\Delta mbase$); for Euro funding conditions, we use $\Delta eonia$. All explanatory variables are included with 1 quarter lag, and standard errors are clustered on time.

Table 9: Additional results II: Splitting sample by geography, US events

	Dependent variable:					
	$\Delta ibkr_{it}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$res_{c,q-1}$	-0.00	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
$gr_{c,q-1}$	0.11***	0.10***	0.10***	0.10***	0.11***	0.11***
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)
$pi_{c,q-1}$	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
	(0.019)	(0.018)	(0.018)	(0.019)	(0.019)	(0.018)
$bf_{c,q-1}$	0.01**	0.01**	0.01**	0.01**	0.01**	0.01**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$stock_{c,q-1}$	0.00	0.00	0.00	0.00	0.00	0.00
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$wf_{c,q-1}$	1.13***	1.67***	0.93**	1.27***	1.32***	1.34***
	(0.409)	(0.506)	(0.360)	(0.351)	(0.360)	(0.362)
$expdep_{c,q-1}$	0.01	0.01	0.01	0.01	0.01	0.01
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$fb_{c,q-1}$	2.44***	2.53***	2.54***	2.43***	3.26***	1.91**
	(0.696)	(0.692)	(0.698)	(0.776)	(0.923)	(0.794)
$ids_{c,q-1}$	0.00	0.00	0.00	0.00	0.00	0.00
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta effr_{q-1}$	0.08	0.07	0.07	0.08	0.07	0.08
	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)
$EM\ EU \times wf_{c,q-1}$	0.87					
	(1.021)					
$EM\ Asia \times wf_{c,q-1}$		-1.25**				
		(0.564)				
$EM\ LatAm \times wf_{c,q-1}$			0.66			
			(0.781)			
$EM\ EU \times fb_{c,q-1}$				0.37		
				(1.446)		
$EM\ Asia \times fb_{c,q-1}$					-1.65	
					(1.161)	
$EM\ LatAm \times fb_{c,q-1}$						1.51
						(1.381)
Observations	858	858	858	858	858	858
No of EMs	16	16	16	16	16	16
R-squared	0.144	0.146	0.145	0.144	0.145	0.145
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	No	No	No
US QE dummies	Yes	Yes	Yes	Yes	Yes	Yes
US TT dummies	Yes	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is $\Delta ibkr$, or change in average quarterly interbank rate (calculated from daily data). The other variables are: GDP growth (gr), inflation (pi), growth of central bank reserves excluding gold (res), growth of cross-border banking flows (bf), growth of the domestic stock market index ($stock$), depreciation of the domestic currency ($expdep$), share of foreign bank assets (fb), growth of international debt securities issuances by non-financial corporates ($idsnfc$), quarterly change in the foreign interest rate (Δi^*), and growth of VIX (vix). wf is our measure of wholesale funding and the main parameter of interest (more in section 3.1). For US dollar funding conditions, we use change in effective federal funds rate ($\Delta effr$). *EM EU* is a dummy variable that takes 1 for Czech Republic, Hungary, Poland and Turkey. Similarly, *EM Asia* for China, Indonesia, India, Malaysia, Philippines, Thailand; *EM LatAm* for Brazil, Chile, Colombia, Mexico and Peru. All explanatory variables are included with 1 quarter lag, and standard errors are clustered on time.

Table 10: Baseline results II: Transmission through wholesale funding and foreign banks

	Dependent variable:					
	$\Delta ibkr_{it}$					
	(1)	(2)	(3)	(4)	(5)	(6)
$res_{c,q-1}$	-0.00	-0.01	-0.00	-0.00	-0.01	-0.00
	(0.006)	(0.007)	(0.007)	(0.005)	(0.005)	(0.007)
$gr_{c,q-1}$	0.11***	0.10***	0.08***	0.11***	0.10***	0.08***
	(0.017)	(0.014)	(0.015)	(0.022)	(0.017)	(0.014)
$pi_{c,q-1}$	-0.01	-0.01	-0.01	-0.01	-0.00	-0.01
	(0.019)	(0.018)	(0.017)	(0.013)	(0.013)	(0.017)
$bf_{c,q-1}$	0.01**	0.01**	0.01*	0.01*	0.01*	0.01*
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)
$stock_{c,q-1}$	-0.00	-0.01**	-0.01	-0.00	-0.01	-0.01
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$fb_{c,q-1}$	2.43***	2.07***	2.18***	2.37***	2.08***	2.17***
	(0.671)	(0.673)	(0.718)	(0.677)	(0.633)	(0.700)
$wf_{c,q-1}$	1.11***	1.18***	1.10***	1.23*	1.10*	1.09***
	(0.342)	(0.408)	(0.363)	(0.646)	(0.554)	(0.358)
$expdep_{c,q-1}$	0.01*	0.01**	0.01**	0.01**	0.01**	0.01**
	(0.006)	(0.006)	(0.006)	(0.005)	(0.004)	(0.006)
$ids_{c,q-1}$	0.00	0.00	0.00	0.00	0.00	0.00
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$vix_{c,q-1}$	-0.01**	-0.00	-0.01***	-0.01*	-0.00*	-0.01***
	(0.003)	(0.002)	(0.002)	(0.003)	(0.001)	(0.002)
$\Delta effr_{q-1}$	-0.43			0.12		
	(0.319)			(0.104)		
$wf_{c,q-1} \times \Delta effr_{q-1}$	-0.99					
	(0.612)					
$\Delta mbasew_{q-1}$		-2.25			-0.63	
		(3.801)			(1.599)	
$wf_{c,q-1} \times \Delta mbasew_{q-1}$		-3.24				
		(5.329)				
$\Delta eonia_{q-1}$			0.59			0.60***
			(0.684)			(0.190)
$wf_{c,q-1} \times \Delta eonia_{q-1}$			0.09			
			(1.281)			
$fb_{c,q-1} \times \Delta effr_{q-1}$				-0.16		
				(0.247)		
$fb_{c,q-1} \times \Delta mbasew_{q-1}$					-0.21	
					(0.976)	
$fb_{c,q-1} \times \Delta eonia_{q-1}$						-0.14
						(0.330)
Observations	858	842	858	858	842	858
No of countries	16	16	16	16	16	16
R-squared	0.159	0.139	0.186	0.156	0.138	0.186
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	No	No	No	No	No	No
US QE dummies	Yes	Yes	No	Yes	Yes	No
US TT dummies	Yes	Yes	No	Yes	Yes	No
EU QE dummies	No	No	Yes	No	No	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is $\Delta ibkr$, or change in average quarterly interbank rate (calculated from daily data). The other variables are: GDP growth (gr), inflation (pi), growth of central bank reserves excluding gold (res), growth of cross-border banking flows (bf), growth of the domestic stock market index ($stock$), depreciation of the domestic currency ($expdep$), share of foreign bank assets (fb), growth of international debt securities issuances by non-financial corporates ($idsnfc$), quarterly change in the foreign interest rate (Δi^*), and growth of VIX (vix). wf is our measure of wholesale funding and the main parameter of interest (more in section 3.1). For US dollar funding conditions, we use change in effective federal funds rate ($\Delta effr$), or growth rate of monetary base which is winsorized at 1% ($\Delta mbasew$); for Euro funding conditions, we use $\Delta eonia$. All explanatory variables are included with 1 quarter lag, and standard errors are clustered on time.

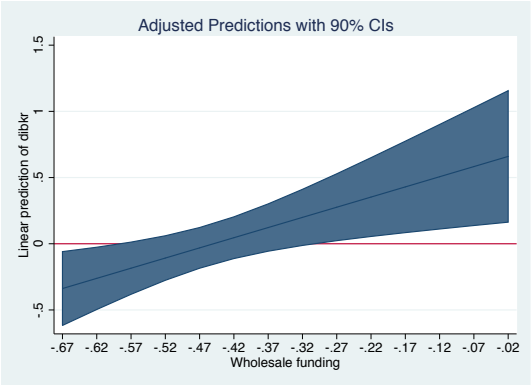
Table 11: Baseline results III: Transmission effects, triple interaction

	Dependent variable:			
	$\Delta ibkr_{it}$			
	(1)	(2)	(3)	(4)
$fb_{c,q-1}$	1.95**	1.59*	1.97**	1.61*
	(0.906)	(0.898)	(0.881)	(0.849)
$wf_{c,q-1}$	0.73	0.56	1.19***	0.98**
	(0.571)	(0.685)	(0.387)	(0.387)
$Post2007Q2$	0.33	0.37	-0.24	-0.15
	(0.338)	(0.374)	(0.229)	(0.209)
$\Delta effr_{q-1}$	-1.31**		0.05	
	(0.601)		(0.292)	
$wf_{c,q-1} \times \Delta effr_{q-1}$	-2.91**			
	(1.179)			
$Post2007Q2 \times wf_{c,q-1}$	0.48	0.50		
	(0.629)	(0.694)		
$Post2007Q2 \times \Delta effr_{q-1}$	1.51**		0.03	
	(0.649)		(0.333)	
$Post2007Q2 \times wf_{q-1} \times \Delta effr_{q-1}$	3.27**			
	(1.282)			
$\Delta eonia_{q-1}$		-1.64		0.56
		(1.100)		(0.547)
$wf_{q-1} \times \Delta eonia_{q-1}$		-3.92**		
		(1.759)		
$Post2007Q2 \times \Delta eonia_{q-1}$		2.80**		-0.01
		(1.273)		(0.580)
$Post2007Q2 \times wf_{q-1} \times \Delta eonia_{q-1}$		5.03**		
		(2.277)		
$fb_{q-1} \times \Delta effr_{q-1}$			0.19	
			(0.735)	
$Post2007Q2 \times fb_{q-1}$			0.68	0.60
			(0.442)	(0.411)
$Post2007Q2 \times fb_{q-1} \times \Delta effr_{q-1}$			-0.32	
			(0.759)	
$fb_{q-1} \times \Delta eonia_{q-1}$				-0.62
				(1.205)
$Post2007Q2 \times fb_{q-1} \times \Delta eonia_{q-1}$				0.78
				(1.253)
All other controls	Yes	Yes	Yes	Yes
Observations	858	858	858	858
No of countries	16	16	16	16
R-squared	0.167	0.197	0.163	0.194
Country FE	Yes	Yes	Yes	Yes
Time FE	No	No	No	No

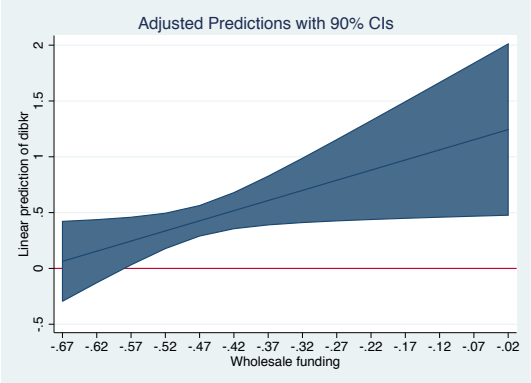
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is $\Delta ibkr$, or change in average quarterly interbank rate (calculated from daily data). All other control variables are included. wf is our measure of wholesale funding and the main parameter of interest. $Post2007Q2$ is a dummy variable that takes value 1 for all periods after 2007 Q2. For US dollar funding conditions, we use change in effective federal funds rate ($\Delta effr$), or growth rate of monetary base which is winsorized at 1% ($\Delta mbasew$); for Euro funding conditions, we use $\Delta eonia$. Columns (1) and (2) show the triple interaction of wholesale funding, foreign liquidity event, and $Post2007Q2$; while columns (3) and (4) show the triple interaction of share of foreign banks, foreign liquidity event, and $Post2007Q2$. All explanatory variables are included with 1 quarter lag, and standard errors are clustered on time.

Figure 17: Transmission of tightening to EM $\Delta ibkr$ via wholesale funding



(a) Effect of wholesale funding on EM rates, US FFR tightening, 2007Q2-2016Q4



(b) Effect of wholesale funding on EM rates, EONIA tightening, 2007Q2-2016Q4

This graph shows the adjusted linear predictions for $\Delta ibkr$ with 90% confidence intervals. Panels (a) - (b) are based on the regression results in column (1) & (2) respectively from table 11. For panel (a), we set $dcris = 1$, i.e. the period between 2007Q2-2016Q4, and $\Delta effr_{q-1} = 0.88$, which is the maximum value for change in effective federal funds rate in our sample, and plot the adjusted predictions for $\Delta ibkr_{c,q}$ keeping all other variables at their means. For panel (b) similarly, we set $dcris = 1$, and $\Delta eonia_{q-1} = 0.68$, the maximum value for change in EONIA in our sample, holding all other variables at their means.

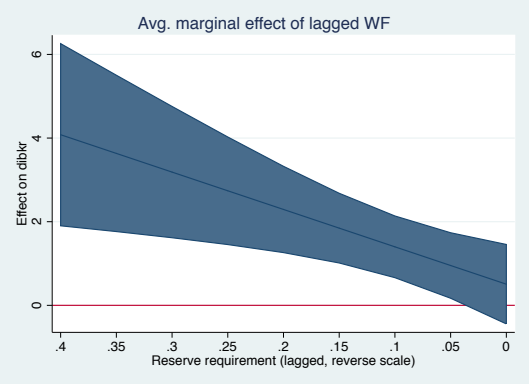
Table 12: Baseline results IV: Mitigating effect of reserve requirements

	Dependent variable:			
	$\Delta ibkr_{it}$			
	(1)	(2)	(3)	(4)
$res_{c,q-1}$	-0.00	-0.00	-0.00	-0.01
	(0.007)	(0.008)	(0.007)	(0.008)
$gr_{c,q-1}$	0.12***	0.10***	0.09***	0.09***
	(0.025)	(0.021)	(0.021)	(0.026)
$pi_{c,q-1}$	-0.03*	-0.02	-0.03	-0.01
	(0.016)	(0.017)	(0.015)	(0.019)
$bf_{c,q-1}$	0.01	0.01	0.01	0.00
	(0.004)	(0.004)	(0.004)	(0.004)
$stock_{c,q-1}$	-0.00	-0.01	-0.01	-0.02*
	(0.005)	(0.005)	(0.005)	(0.007)
$fb_{c,q-1}$	1.77*	1.48	1.59*	0.69
	(0.927)	(0.933)	(0.773)	(1.001)
$wf_{c,q-1}$	0.51	0.43	0.49	0.12
	(0.485)	(0.478)	(0.474)	(0.540)
$rrf_{c,q-1}$	6.17***	5.49***	5.37***	4.85**
	(1.638)	(1.475)	(1.345)	(1.742)
$wf_{c,q-1} \times rrf_{c,q-1}$	8.93**	8.05**	7.55**	7.31**
	(3.383)	(3.079)	(2.949)	(3.389)
$ids_{c,q-1}$	0.00	0.00	0.00	-0.00
	(0.002)	(0.002)	(0.002)	(0.002)
$expdep_{c,q-1}$	0.01***	0.01***	0.02***	0.02**
	(0.005)	(0.004)	(0.005)	(0.006)
vix_{q-1}	-0.01**	-0.00**	-0.01***	
	(0.003)	(0.002)	(0.002)	
$\Delta effr_{q-1}$	0.03			
	(0.095)			
$\Delta mbasew_{q-1}$		-0.34		
		(1.334)		
$\Delta eonia_{q-1}$			0.51***	
			(0.116)	
Observations	761	746	761	761
No of countries	16	16	16	16
R-squared	0.181	0.156	0.206	0.297
Country FE	Yes	Yes	Yes	Yes
Time FE	No	No	No	Yes
QE dummies	Yes	Yes	No	No
TT dummies	Yes	Yes	No	No
EU QE dummies	No	No	Yes	No

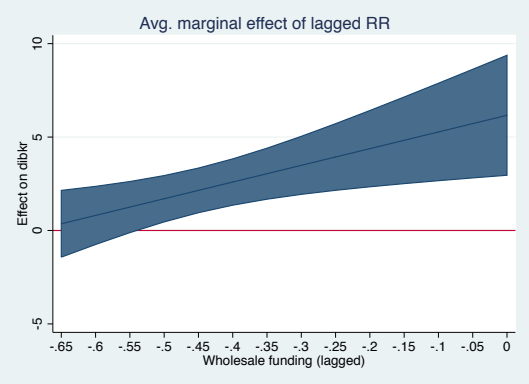
Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable, $\Delta ibkr$, is the change in average quarterly interbank rate (calculated from daily data). The other explanatory variables are as follows. res is the quarterly growth rate of total international reserves excluding gold. pi is the quarterly inflation rate for each country. bf is the quarterly growth rate of total outstanding cross-border banking flows from the rest of the world to country c. $stock$ is quarterly growth rate in country c's stock market. wf is our measure of wholesale funding and the main parameter of interest (more in section 3.1). rrf is the average reserve requirement for country c, taken from Federico *et al.* (2014). $expdep$ is the quarterly depreciation of the country's exchange rate. fb is the share of foreign bank assets in the total banking sector's assets. ids is the international debt issuances. For US dollar funding conditions, we use change in effective federal funds rate ($\Delta effr$), or growth rate of monetary base which is winsorized at 1% ($\Delta mbasew$); for Euro funding conditions, we use $\Delta eonia$. All explanatory variables are included with 1 quarter lag, and standard errors are clustered on time.

Figure 18: Wholesale funding and reserve requirements



(a) $\frac{\partial(\Delta ibkr)}{\partial(WF)}$



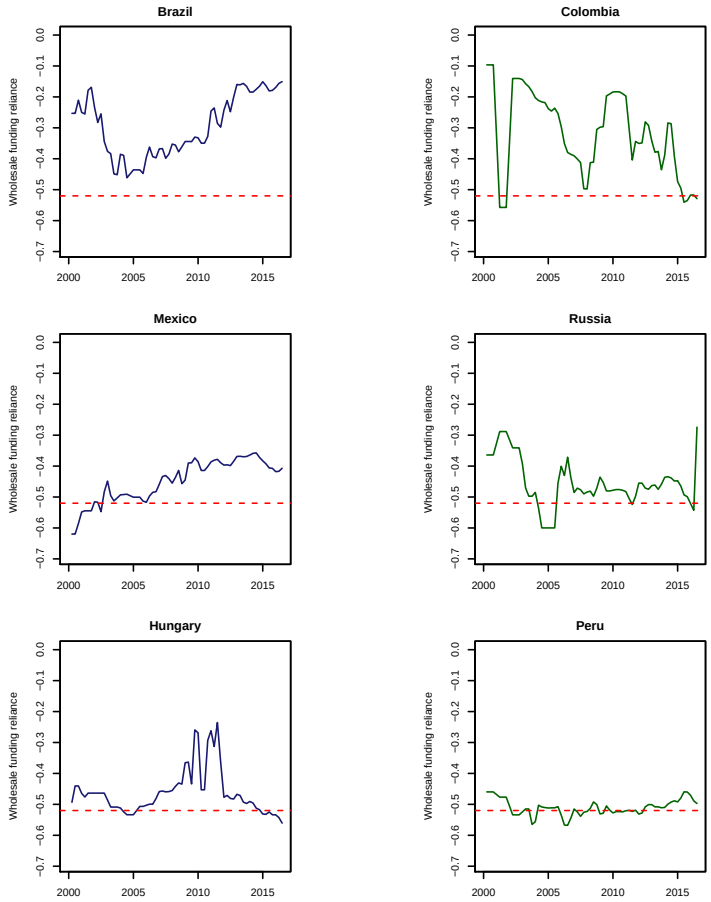
(b) $\frac{\partial(\Delta ibkr)}{\partial(RR)}$

Note: This graph shows the interaction effect of wholesale funding and reserve requirements. Data for reserve requirements is taken from Federico *et al.* (2014) and ends in 2015 Q3, hence the reduction in number of observations. In panel (a), we show the effect on interbank rates of reducing reserve requirements from 0.4 (the maximum in our sample) to 0 (the minimum) given average wholesale funding. In panel (b), we show what happens to interbank rates when a country moves from almost no wholesale funding (-0.65) to full reliance on wholesale funding (0), given average reserve requirements. This is based on the regression results in column (1) from table 12.

Appendices

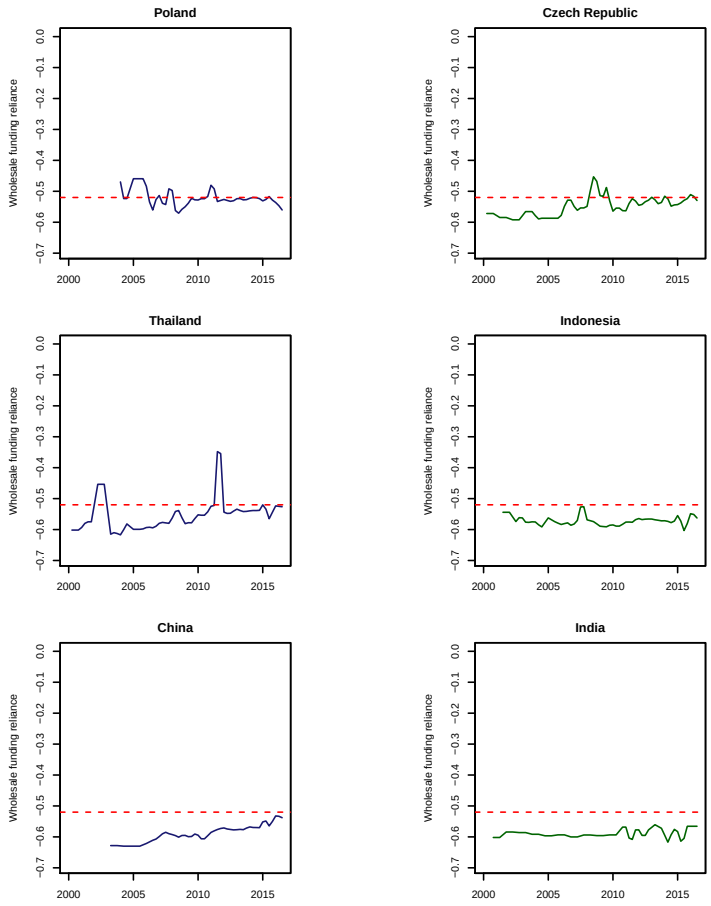
A Additional tables and figures

Figure A.1: 2Q rolling wholesale funding measure: Countries above median



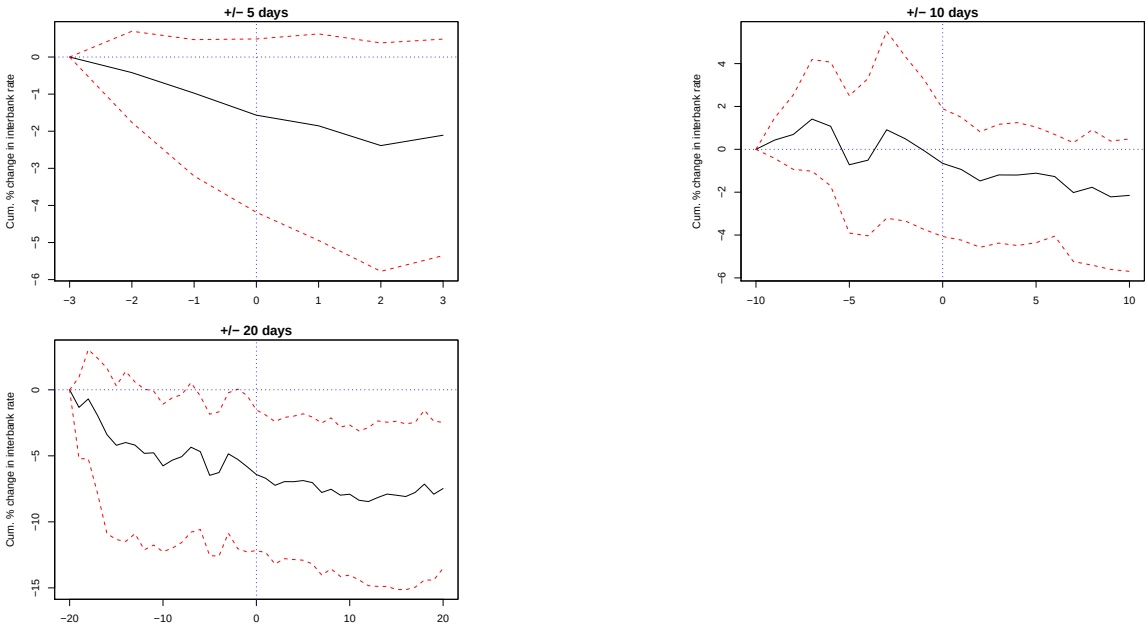
Note: The figure shows countries with most number of quarters above median wholesale funding reliance from figure 7. Wholesale funding reliance is measured as $W^m_{i,c,q} = -log(1+\Sigma_{i,c,q}[(\frac{Assets\ of\ bank_{i,c,q}}{Total\ assets_{c,q}} \times \frac{Total\ retail\ deposits_{i,c,q}}{Total\ liabilities_{i,c,q}})])$. The measure is bound between -0.69, the minimum, indicating no wholesale funding reliance and 0, the maximum, indicating complete reliance on wholesale funding. The red dashed line is the median (-0.52) for the entire sample.

Figure A.2: 2Q rolling wholesale funding measure: Countries below median



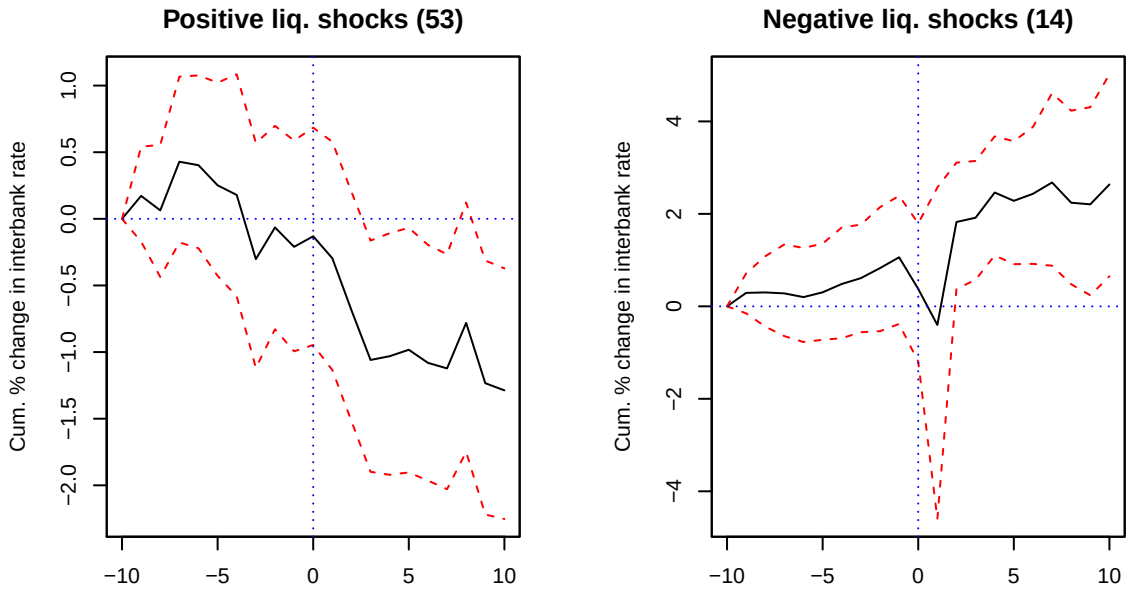
Note: The figure shows countries with most number of quarters below median wholesale funding reliance from figure 7. Wholesale funding reliance is measured as $W^m_{i,c,q} = -log(1+\Sigma_{i,c,q}[(\frac{Assets\ of\ bank_{i,c,q}}{Total\ assets_{c,q}} \times \frac{Total\ retail\ deposits_{i,c,q}}{Total\ liabilities_{i,c,q}})])$. The measure is bound between -0.69, the minimum, indicating no wholesale funding reliance and 0, the maximum, indicating complete reliance on wholesale funding. The red dashed line is the median (-0.52) for the entire sample.

Figure A.3: Event study: Cumulative % change in EM interbank rate due to Draghi "whatever it takes" speech



Note: This graph shows the cumulative percent change in EM interbank rate in response to the "whatever it takes" speech by Mario Draghi, President of the European Central Bank, on 26/07/2012.

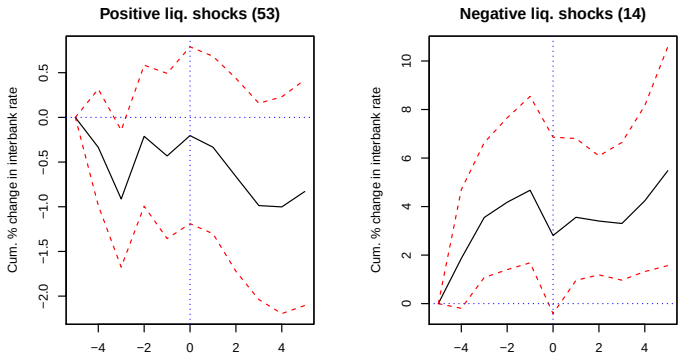
Figure A.4: Event study: Cumulative % change in EM interbank rate, ±10 days



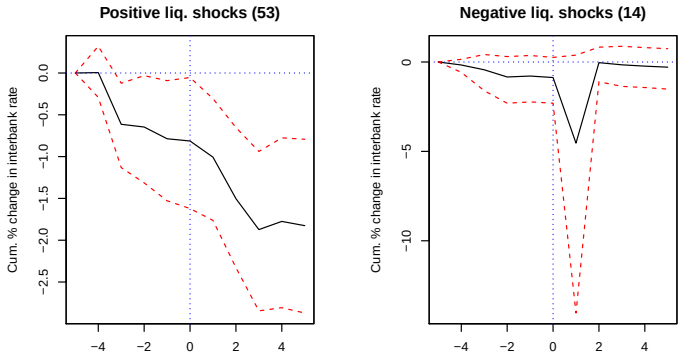
Note: This graph shows the cumulative percent change in EM interbank rate in response to all (a) positive and (b) negative liquidity events by the Fed & ECB between 2007 - 2018, using a ±10 day window. The sample consists of 23 emerging economies from the MSCI EM index, and events are shown in appendix C.

Figure A.5: Event study: Split sample by share of foreign banks

Panel (a): Above-median share of foreign banks, 10 countries

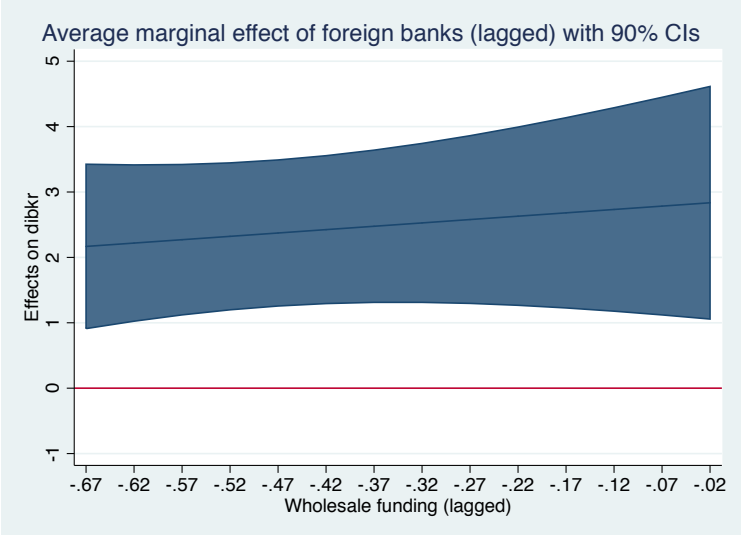


Panel (b): Below-median share of foreign banks, 11 countries



Note: We split our sample of countries into above and below-median share of foreign banks in panel (a) and (b) respectively. The countries in panel (a) are Brazil, Chile, Czech Republic, Egypt, Hungary, Indonesia, Mexico, Peru, and Polans. Countries in panel (b) are China, Colombia, India, South Korea, Malaysia, Philippines, Russia, Thailand, Turkey and South Africa. The full sample consists of 23 emerging economies from the MSCI EM index, and events are shown in greater detail in appendix C.

Figure A.6: Interaction of wholesale funding and foreign banks



Note: This graph shows average marginal effect of share of foreign banks (lagged) on change in interbank rates ($\Delta ibkr$) at different levels of wholesale funding (90% confidence intervals). This is based on a panel regression which contains all the control variables from table 6, along with country fixed effects, with clustering by time.

Table A.1: Additional results: Pre-post crisis using interaction

	Dependent variable:		
	$\Delta ibkr_{it}$		
	(1)	(2)	(3)
$res_{c,q-1}$	-0.00	-0.01	-0.00
	(0.007)	(0.006)	(0.007)
$gr_{c,q-1}$	0.11***	0.10***	0.08***
	(0.018)	(0.014)	(0.014)
$pi_{c,q-1}$	-0.01	-0.00	-0.00
	(0.019)	(0.018)	(0.018)
$bf_{c,q-1}$	0.01**	0.01**	0.01*
	(0.003)	(0.003)	(0.003)
$stock_{c,q-1}$	-0.00	-0.01**	-0.01
	(0.004)	(0.004)	(0.004)
$wf_{c,q-1}$	1.16***	1.05***	0.95**
	(0.386)	(0.383)	(0.386)
$expdep_{c,q-1}$	0.01**	0.01**	0.01**
	(0.006)	(0.006)	(0.006)
$fb_{c,q-1}$	2.03**	1.85**	1.64*
	(0.885)	(0.873)	(0.866)
$ids_{c,q-1}$	0.00	0.00	0.00
	(0.002)	(0.002)	(0.002)
$vix_{c,q-1}$	-0.01**	-0.00*	-0.01***
	(0.003)	(0.002)	(0.002)
$Post2007Q2$	0.07	0.11	0.12
	(0.113)	(0.191)	(0.108)
$\Delta effr_{q-1}$	0.14		
	(0.135)		
$Post2007Q2 \times \Delta effr_{q-1}$	-0.12		
	(0.159)		
$gr.mbasew_{q-1}$		4.56	
		(12.077)	
$Post2007Q2 \times \Delta mbasew_{q-1}$		-5.34	
		(12.184)	
$\Delta eonia_{q-1}$			0.30
			(0.323)
$Post2007Q2 \times \Delta eonia_{q-1}$			0.32
			(0.311)
Observations	858	842	858
No of countries	16	16	16
R-squared	0.157	0.139	0.190
Country FE	Yes	Yes	Yes
Time FE	No	No	No
US QE dummies	Yes	Yes	No
US TT dummies	Yes	Yes	No
EU QE dummies	No	No	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: The dependent variable is $\Delta ibkr$, or change in average quarterly interbank rate (calculated from daily data). The other variables are: GDP growth (gr), inflation (pi), growth of central bank reserves excluding gold (res), growth of cross-border banking flows (bf), growth of the domestic stock market index ($stock$), depreciation of the domestic currency ($expdep$), share of foreign bank assets (fb), growth of international debt securities issuances by non-financial corporates ($idsnfc$), quarterly change in the foreign interest rate (Δi^*), and growth of VIX (vix). wf is our measure of wholesale funding and the main parameter of interest (more in section 3.1). $Pre2007Q2$ is the period from 2000 Q1 till 2007 Q2; $Post2007Q2$ is the period from 2007 Q3 to 2016 Q4. For US dollar funding conditions, we use change in effective federal funds rate ($\Delta effr$), or growth rate of monetary base which is winsorized at 1% ($\Delta mbasew$); for Euro funding conditions, we use $\Delta eonia$. All explanatory variables are included with 1 quarter lag, and standard errors are clustered on time.

B Data description

Table B.1: Coverage of EMs and main money market rate used

Country	**Money market rate**	**Notes**
Argentina	Interbank (up to 15 days): Interest rate	1991-2018
Brazil	Interbank O/N: Interest rate	CDI Rate, 1993-2018
China	Interbank O/N: Offered rate	SHIBOR, 2001-2018
Chile	Interbank O/N: Interest rate	1995-2018
Colombia	Interbank O/N: interest rate	2001-2018
Czech Republic	Interbank O/N: interest rate	PRIBOR, 1992-2015
Egypt	Interbank O/N:interest rate	2007-2018
Hungary	Interbank O/N: interest rate	1995-2018
India	Call money rate: Interest rate	MIBOR, 1996-2018.
Indonesia	Interbank O/N: Interest rate	1996-2018
Malaysia	Interbank O/N: Interest rate	KLIBOR, 1993-2018
Mexico	Interbank O/N: Interest rate	TIIE, 1995-2018
Poland	Interbank O/N: Interest rate	WIBOR O/N delayed, 1994-2018
Peru	Interbank O/N: Repo rate overnight	1999-2018
Philippines	Interbank call loan rate: Interest rate	1990-2018
Qatar	Interbank O/N: Interest rate	QIBOR, 2013-2018
Russia	Interbank 1D: Interest rate	MOWIBOR, 1998-2018
South Africa	Interbank call: Interest rate	IBK call, 1981-2018
	SABOR	2007:2018
South Korea	Interbank O/N call rate: Interest rate	(chosen based on literature), 1993-2018
Thailand	Interbank O/N: Middle rate	1991-2018
Taiwan	Interbank swap overnight: Interest rate	1988 - 2018
Turkey	Interbank O/N: Middle rate	2006-2018
UAE	Interbank O/N: Interest rate	EIBOR, 2013-2018

Table B.2: Variables and data sources

Variable	Unit	Source	Frequency
Dependent variables			
Overnight interbank rates	Percentage	Datastream	Daily
Explanatory variables			
1. Foreign factors			
US shadow rate	Percentage	Wu & Xia (2016)	Daily
VIX	Price	CBOE	Daily
MBS holdings by Fed, all maturities	USD Millions	FRED, St. Louis Fed	Weekly
Treasury bond holdings by Fed, all maturities	USD	FRED, St. Louis Fed	Weekly
Monetary base	USD	FRED, St. Louis Fed	Weekly
2. Trilemma factors			
Exchange rate	Price	Datastream	Daily
Capital account openness	Index	Fernandez *et al*, 2015	Annual
Capital account openness	Index	Chinn-Ito	Annual
3. International financial linkages			
Cross-border banking flows	USD Millions	BIS Locational Statistics	Quarterly
IDS (nationality & residence)	USD Billions	BIS Securities Statistics	Quarterly
4. Domestic banking sector factors			
Total assets	USD Millions	Bankscope	Quarterly
Total liabilities	USD Millions	Bankscope	Quarterly
Total deposits	USD Millions	Bankscope	Quarterly
Deposits from banks	USD Millions	Bankscope	Quarterly
Reserve requirements	Average, index	Federico *et al* (2014)	Quarterly
Bank deposits to GDP	Percentage	WDI, World Bank	Annual
Bank ROA/ROE	Percentage	WDI, World Bank	Annual
Share of foreign bank assets in total	Percentage	WDI, World Bank	Annual
Banking sector fragility	Index	Demetriades *et al*, 2015	Annual
Dependence on wholesale funding	Index	Raddatz *et al*, 2012	For 2007
5. Domestic macro-financial factors & other controls			
Stock market performance	Percentage	Datastream	Daily
GDP growth, YoY	Percentage	IFS	Quarterly
CAD to GDP, YoY	Percentage	Thomson Reuters	Quarterly
Reserves (Excl. gold)	USD Millions	IFS	Quarterly
Monetary base to GDP	Percentage	IFS	Quarterly
Inflation	Percentage	CEIC	Quarterly

Note: This table shows the variables, data sources and their units and frequencies used in the paper.

C Liquidity events

Table C.1: Liquidity events in US, 2007-2018

Date	Type	Event	Loosening	Tightening	Source
18/09/2007	Fed MP	Fed lowers target for the federal funds rate by 50 bps. Also approve a 50 bps reduction in the discount rate	1	0	FOMC Press Release (Sep '07)
31/10/2007	Fed MP	Fed lowers target for the federal funds rate by 25 bps. Also approves a 25 bps reduction in the discount rate	1	0	FOMC Press Release (Oct '07)
11/12/2007	Fed MP	Fed lowers target for the federal funds rate by 25 bps. Also approves a 25 bps reduction in the discount rate	1	0	FOMC Press Release (Dec '07)
30/01/2008	Fed MP	Fed lowers target for the federal funds rate by 50 bps. Also approves a 50 bps reduction in the discount rate	1	0	FOMC Press Release (Jan '08)
18/03/2008	Fed MP	Fed lowers target for the federal funds rate by 75 bps. Also approves a 75 bps reduction in the discount rate	1	0	FOMC Press Release (Mar '08)
30/04/2008	Fed MP	Lowers target for the FFR, and the discount rate by 25 bps each	1	0	FOMC Press Release (Apr '08)
21/10/2008	Fed CE	Announces creation of Money Market Investor Funding Facility (MMIFF) to act as a source of liquidity to money market mutual funds	1	0	FOMC Press Release (Oct '08)
29/10/2008	Fed MP	Lowers target for the FFR, and the discount rate by 50 bps each	1	0	FOMC Press Release (Oct '08)
25/11/2008	Fed QE1	Creation of the Term-Asset Backed Securities Loan Facility (TALF) and initiation of Large-scale asset purchases (LSAPs). Announces purchase of $100 bn in government-sponsored enterprise (GSE) debt and up to $500 bn in mortgage-backed securities	1	0	FOMC Press Release (Nov '08)
16/12/2008	Fed MP	Lowers target for the FFR to 0-0.25% and approves a 75 bps reduction in discount rate to 0.5%	1	0	FOMC Press Release (Dec '08)
07/01/2009	Fed CE	Announces two changes to MMIFF: 1) increases participation by other money market investors 2) adjustment of several economic parameters such as the minimum yield on assets eligible to be sold to the MMIFF	1	0	FOMC Press Release (Jan '09)
10/02/2009	Fed CE	FRB announces possibility of substantial expansion in TALF, increasing its size to $1 trillion, and other types of assets	1	0	FOMC Press Release (Feb '09)
18/03/2009	Fed QE	Announces purchase of additional 750$bninagencyMBS$,100 bn in agency debt, and additional $300 bn of longer term Treasury securities	1	0	FOMC Press Release (Mar '09)
19/03/2009	Fed QE	Increases the set of eligible collateral for loans extended under TALF	1	0	FOMC Press Release (Mar '09)
27/01/2010	Fed QE	Announces the closing of Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility, the Commercial Paper Funding Facility, the Primary Dealer Credit Facility, and the Term Securities Lending Facility on February 1	0	0	FOMC Press Release (Jan '10)
27/08/2010	Fed QE2	Bernanke hints at QE2 in his speech at Federal Reserve Bank of Kansas City Symposium.	1	0	Speech (Aug '10)
15/10/2010	Fed QE2	Bernanke's speech at Boston Fed: "there would appear- all else being equal - to be a case for further action".	1	0	Speech (Oct '10)
03/11/2010	Fed QE2	Expands QE to $75 bn per month	1	0	FOMC Press Release (Nov '10)
21/09/2011	Fed OT	Announces extension of the average maturity of holdings securities by purchasing $400 bn in long-term securities and sale of equivalent amount in short-term securities (Operation Twist)	1	0	FOMC Press Release (Sep '11)
20/06/2012	Fed OT-E	Fed extends Operation Twist till at least the end of 2012	1	0	FOMC Press Release (Jun '12)
22/08/2012	Fed QE3	Release of the minutes of the FOMC meeting of August where FOMC members judge that additional monetary accommodation is likely	1	0	FOMC Press Release (Aug '12)
31/08/2012	Fed QE3	Bernanke hints at QE3 by stating: âĂIJThe Federal Reserve will provide additional policy accommodation as needed to promote a stronger economic recovery of price stability.âĂİ	1	0	Speech (Aug '12)
13/09/2012	Fed QE3	Starts purchases of $40 bn MBS/ month in addition to $45 bn of longer-term Treasury securities per month	1	0	FOMC Press Release (Sep '12)
12/12/2012	Fed QE3	FOMC expands QE3.	1	0	FOMC Press Release (Dec '12)
01/05/2013	Fed TT	FOMC statement modifies language about QE3, stating that it is "prepared to increase or decrease pace of purchases to maintain appropriate policy accommodation"	1	0	FOMC Press Release (May '13)
22/05/2013	Fed TT	Ben Bernanke announces to Congress that Fed may adjust or reduce its monthly asset purchases based on its outlook for inflation and employment	0	0	FOMC Press Release (May '13)
19/06/2013	Fed TT	Bernanke's says in a press conference that if data remains aligned with Fed expectations, then reduction in asset purchases would start by beginning of 2014, ending by md-2014	0	0	FOMC Press Release (Jun '13)
18/09/2013	Fed QE	Fed decides not to taper i.e. reduce its monthly purchases of long-term Treasury securities and MBS	1	0	FOMC Press Release (Sep '13)
18/12/2013	Fed QE	Fed starts reducing pace of monthly MBS and Treasury securities by $5 bn per month for the next one year	0	0	FOMC Press Release (Dec '13)
29/10/2014	Fed QE	Fed's purchases of MBS and longer-term Treasury securities ends. Target for FFR is 0-0.25%	0	0	FOMC Press Release (Oct '14)
16/12/2015	Fed MP	Fed lifts off. Target for FFR raised to 0.25-0.5%	0	1	FOMC Press Release (Dec '15)
14/12/2016	Fed MP	Target for FFR raised to 0.5-0.75%	0	1	FOMC Press Release (Dec '16)
15/03/2017	Fed MP	Target for FFR raised to 0.75-1%	0	1	FOMC Press Release (Mar '17)
14/06/2017	Fed MP	Target for FFR raised to 1-1.25%.Fed statement says: "The committee currently expects to begin implementing a balance sheet normalisation program this year"	0	1	FOMC Press Release (Jun '17)
13/12/2017	Fed MP	Target for FFR raised to 1.25-1.5%	0	1	FOMC Press Release (Dec '17)
21/03/2018	Fed MP	Target for FFR raised to 1.5-1.75%	0	1	FOMC Press Release (Mar '18)
13/06/2018	Fed MP	Target for FFR raised to 1.75-2%	0	1	FOMC Press Release (Jun '18)
26/09/2018	Fed MP	Target for FFR raised to 2-2.25%	0	1	FOMC Press Release (Sep '18)
19/12/2018	Fed MP	Target for FFR raised to 2.25-2.5%	0	1	FOMC Press Release (Dec '18)

MP: Change in rates; CE = Credit easing (Fawley & Neely, 2013)
QE = Quantitative easing (Fawley & Neely 2013); OT = Operation Twist
OT-E = Operation Twist - Extension; TT = Taper tantrum
Note: Only events where changes take place are reported.

Table C.2: Liquidity events in Europe, 2007-2018

Date	Type	Event	Source
08 Mar '07	ECB MP	ECB increases minimum bid rate on the MROs by 25bps, and increases interest rates on marginal lending facility and deposit facility by same amount	ECB Monthly Bulletin (Dec '10)
06 Jun '07	ECB MP	ECB increases minimum bid rate on the MROs by 25bps and increases interest rates on marginal lending facility and deposit facility by same amount	ECB Monthly Bulletin (Dec '10)
03 Jul '08	ECB MP	"	ECB Monthly Bulletin (Dec '10)
08 Oct '08	ECB MP	ECB reduces the above three rates by 50 bps. Reduces corridor of standing facilities from 200 bps to 100 bps around the interest rate of the MRO rate	ECB Monthly Bulletin (Dec '10)
15 Oct '08	ECB CE	ECB expands collateral framework and increase provision of liquidity by: 1) expanding list of assets eligible as collateral in Eurosystem credit ops 2) increase provision of LTROs 3) provide USD liquidity via FX swaps	ECB Monthly Bulletin (Dec '10)
06 Nov '08	ECB MP	All three main rates decreased by 50 bps	ECB Monthly Bulletin (Dec '10)
04 Dec '08	ECB MP	All three main rates decreased by 75 bps	ECB Monthly Bulletin (Dec '10)
18 Dec '08	ECB CE	Corridor of standing facility rates re-widened symmetrically to 200 bps	ECB Monthly Bulletin (Dec '10)
15 Jan '09	ECB MP	All three interest rates decreased by 50 bps	ECB Monthly Bulletin (Dec '10)
05 Mar '09	ECB MP	All three interest rates decreased by 50 bps	ECB Monthly Bulletin (Dec '10)
02 Apr '09	ECB MP	Interest rates further cut by 25 bps	ECB Monthly Bulletin (Dec '10)
07 May '09	ECB MP	ECB reduces MRO rate by 25 bps, marginal lending facility rate by 50 bps, and leaves the deposit facility unchanged	ECB Monthly Bulletin (Dec '10)
07 May '09	ECP CE	Eurosystem will conduct liquidity providing 1-year LTROs as fixed rate tender with full allotment, and will also purchase euro-denominated covered bonds issued in euro area	ECB Monthly Bulletin (Dec '10)
10 May '10	ECB CE	Interventions in the euro area public and private debt securities markets (SMPs) and conduct 3 month LTROs	ECB Monthly Bulletin (Dec '12)
07 Apr '11	ECB MP	Rates on MROs, marginal lending facility, and deposit facility increased by 25 bps each	ECB Monthly Bulletin (Dec '12)
07 Jul '11	ECB MP	Rates on MROs, marginal lending facility, and deposit facility increased by 25 bps each	ECB Monthly Bulletin (Dec '12)
06 Sep '11	SNB ER	SNB introduces floor of 1.2 CHF per EUR and prepares itself to buy currency in "unlimited" quantities to defend the floor	SNB Press Release
06 Oct '11	ECB CE	Interest rates unchanged, but ECB introduces two LTROs of 12 and 13 months each	ECB Monthly Bulletin (Dec '12)
03 Nov '11	ECB MP	All 3 interest rates decreased by 25 bps each	ECB Monthly Bulletin (Dec '12)
08 Dec '11	ECB MP	ECB announces 36 month LTROs and decreases all three rates.	Fawley & Neely (2013)
05 Jul '12	ECB MP	ECB decreases interest rates on MROs, marginal lending facility, and deposit facility, by 25 bps	ECB Monthly Bulletin (Oct '14)
26 Jul '12	ECB WIT	Mario Draghi's "Whatever it takes" speech	ECB website
02 May '13	ECB MP	ECB decreases interest rate on MROs by 25 bps, on marginal lending facility by 50 bps, and leaves deposit facility at 0%	ECB Monthly Bulletin (Oct '14)
07 Nov '13	ECB MP	Interest rate on MROs and marginal lending facility reduced further by 25bps, leaving deposit facility at 0%	ECB Monthly Bulletin (Oct '14)
05 Jun '14	ECB MP	Interest rates on MROs, marginal lending facility, and deposit facility reduced by 10 bps. Deposit facility interest rate hits -0.10%	ECB Monthly Bulletin (Oct '14)
05 June '14	ECB MP	Rates cuts. Announces series of TLTRO (TLTRO I), 3 month LTROs, and announces possibility of outright purchases in ABS market	ECB Press Release (Jun '14)
04 Sep '14	ECB MP	Interest rates on MROs, marginal lending facility, and deposit facility reduced by 10 bps. Deposit facility interest rate hits -0.20%	ECB Monthly Bulletin (Oct '14)
15 Jan '15	SNB ER	SNB discontinues minimum exchange rate (floor) on the CHF/EUR, & reduces deposit rate to -0.75% and target range of 3-month LIBOR to -1.25% and -0.25%	SNB Press Release (Jan '15)
22 Jan '15	ECB QE	ECB expands purchases to include bonds issued by euro area central governments, agencies & institutions, amounting to EUR60 bn per month, at least until Sep '16	ECB Press Release
03 Dec '15	ECB MP	ECB reduces deposit facility rate by 10 bps to -0.3%, leaving MRO and marginal lending facility rate unchanged	ECB Press Release (Dec '15)
10 Mar '16	ECB MP	Reduces MRO rate by 5bps to 0%, the marginal lending facility rate by 5 bps to 0.25%, and deposit facility rate by 10 bps to -0.4%	ECB Press Release (Mar '16)
10 Mar '16	ECB QE	Pace of monthly purchases under asset purchase program expanded to EUR80 bn from April. Investment grade euro-denominated bonds issued by non-bank corporations from euro-area is included in list of assets eligible for regular purchases.	ECB Press Release (Mar '16))
10 Mar '16	ECB CE	Borrowing fromTLTRO-II with interest rate as low as deposit rate and for maturity of 4 years is announced.	ECB Press Release (Mar '16)
21 Jul '16	ECB QE	Rates unchanged. Extends QE to Mar '17 or beyond	ECB Press Release (Jul '16)
19 Jan '17	ECB QE	Rates are unchanged but extends QE to December 2017 or beyond	ECB Press Release (Jan '17)
27 Apr '17	ECB QE	No change in rates. Asset purchases to be made at the slower rate of EUR60 bn per month	ECB Press Release (Apr '17)
26 Oct '17	ECB QE	Rates unchanged. APP to continue at a slower monthly pace in 2018	ECB Press Release (Oct '17)
14 Jun '18	ECB QE	Monthly pace of net asset purchases reduced to EUR 15 bn until December 2018, and then ended.	ECB Press Release (Jun '18)

MP = Monetary policy; WIT = Draghi "whatever it takes"; QE = quantitative easing; CE = credit easing (for details, see Borio and Disyatat, 2010).
Note: The ECB Monthly Bulletins cited here provide a chronology of all MP actions taken. See page 194 onwards in Bulletin (2010) and page 192 onwards in Bulletin (2012). Only events where changes are announced are reported. Loosening and tightening dummies not reported here in the interest of space.